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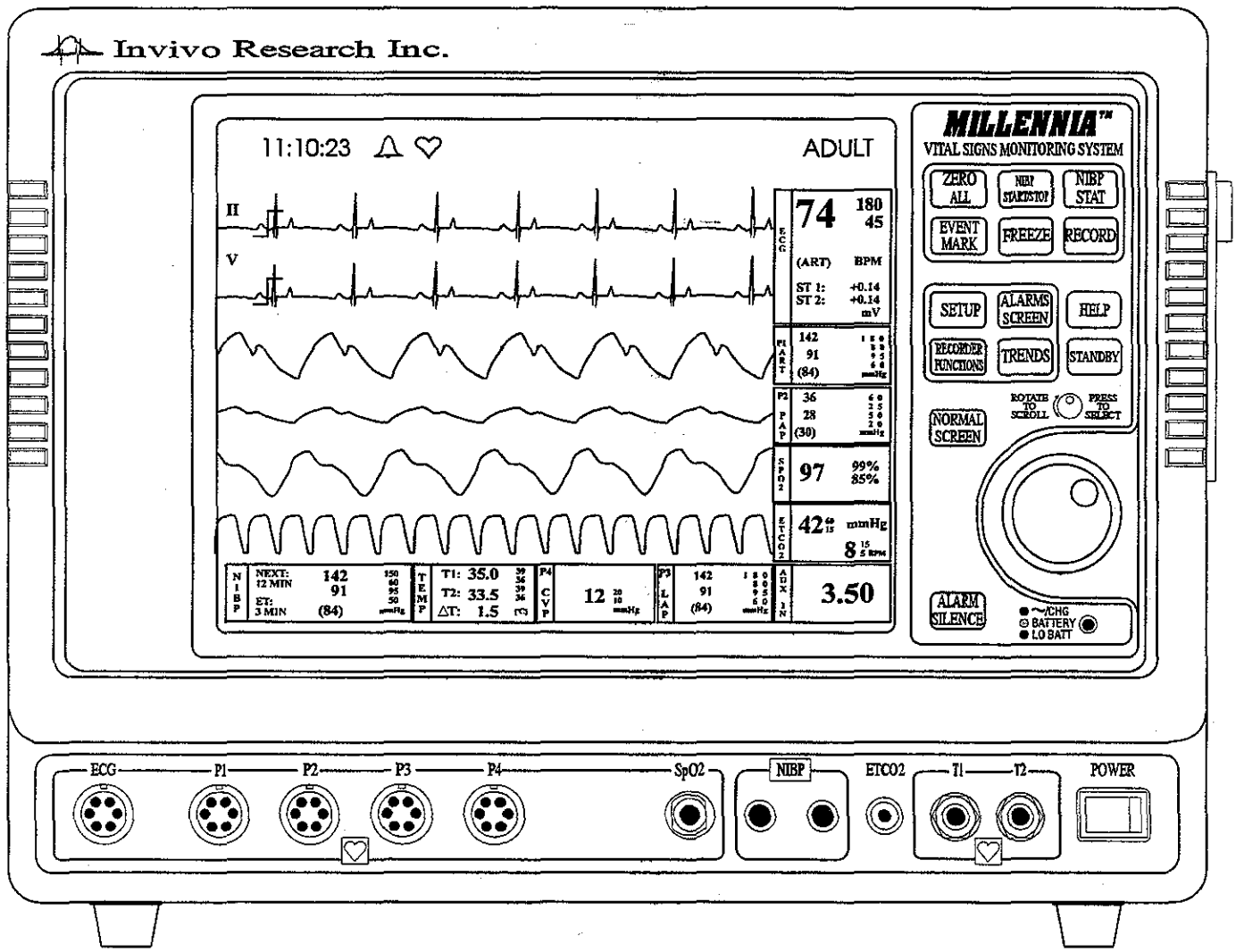

Millennia™ Vital Signs Monitor

Service Manual

Invivo Research, Inc.

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Invivo Research, Incorporated

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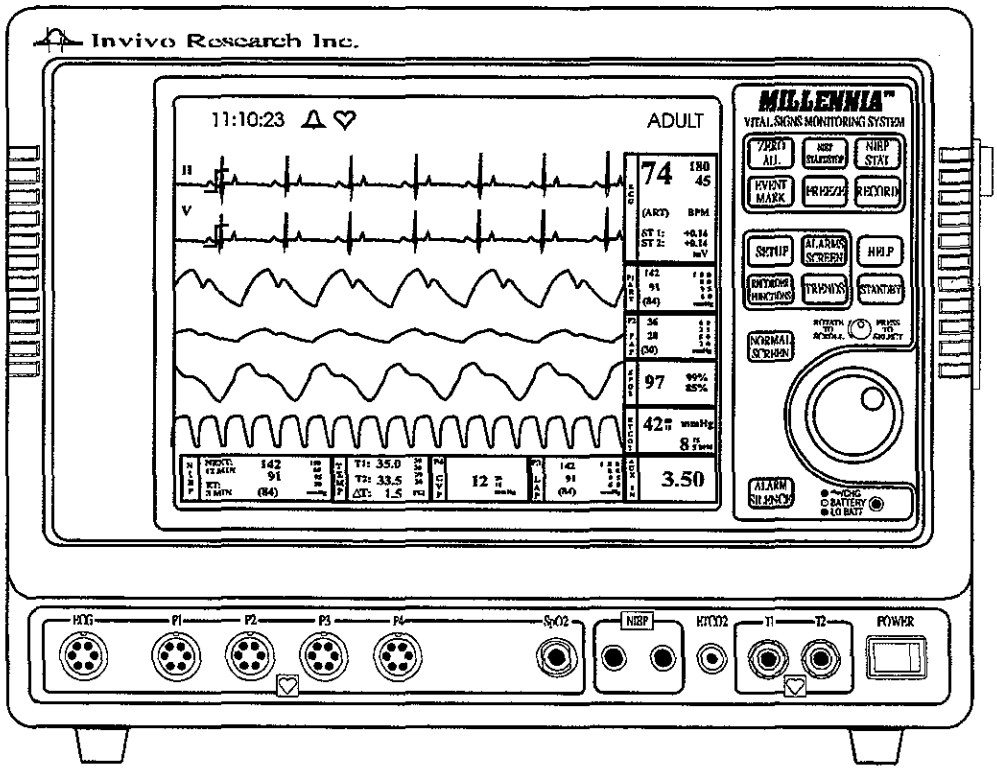

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SECTION I

THEORY OF OPERATION

1.0 THEORY OF OPERATION.

NOTE

This manual describes a fully configured monitor, and may include features and/or options that are not included in your monitor. For additional information, contact your local sales representative, or Invivo Research Inc. Customer Service.

1.1 Power Supply. Power is supplied to this monitors operational circuits by the AB69 and AB69A Power Supply Boards. AB69 and AB69A supply +12 Vdc, -12 Vdc, +5 Vdc, -5 Vdc and +3 Vdc to the different operational areas of the Millennia. This power is used to run the recorder, supply the NIBP pump (while maintaining overpressure override control), provide alarm audio drive to the speaker and to provide front-panel LED illumination as an indication of the state of the input power and the condition of the batteries. In terms of the battery system: the AB69 and AB69A boards charge and monitor the charge-state of the batteries, provide operation from the batteries in the event of power failure or AC Line Power disconnection, issues an early warning when the batteries are low and provides for controlled shut down of the monitor when the batteries are discharged.

1.1.1 AB69 and AB69A Location. The AB69 and AB69A Power Supply Boards are stacked with the AB69A on top. They are located immediately in front of the Processor Motherboard in the center of the case.

1.1.2 Charger Circuit. The charger circuit is located on the AB69A board (upper board, on the left half of the board. Please refer to the left half of drawing 185C197. The circuit is a buck-type switching regulator with current limiting and a charge-cutoff circuit.

Consider the charger switcher first: Q1, the current switch transistor, is driven by transistor Q4. A typical cycle of switching proceeds as follows: transistor Q1 turns on and applies the supply voltage (typically 18 to 14 volts) to inductor L1. The current through inductor L1 ramps up until the voltage across resistor R17, and the voltage between the emitter and the base of transistor Q3 rises enough to turn on transistor Q3. When transistor Q3 turns on, it shorts out the base-emitter drive into transistor Q2, and Q2 turns off. Transistor Q4 shuts off as there is now no current through resistor R14, and thus no voltage drop. When transistor Q4 turns off, transistor Q1 has no drive, and its output voltage falls to zero. The current through inductor L1 decays according to its time-constant, with diode D8 supplying the decaying current. Capacitor C4 smooths the output voltage from inductor L1. The overall action produces a set of rising and falling current-ramp waveforms that average out to a controlled charging current into the battery.

When the battery has charged sufficiently, the voltage on op amp U1 pin 2 now rises above the voltage on pin 3, and pin 1's voltage falls to ground. This forward-biases diode D3 with current being drawn through resistors R9 and R11. The voltage across resistor R11 is now enough to turn on transistor Q5. When transistor Q5 turns on, the base-emitter voltage across transistor Q2 becomes zero, and transistor Q2 turns off. This action will override the switching action just described and turn the charger off. The charger stays off until the battery voltage drops enough to initiate charging.

When the voltage on U1 pin 2 falls below that of pin 3, then pin 1 of U1 rises, turning off diode D3, and allowing the transistor Q2 to again have bias. The charger restarts. The circuit of resistor R8 and the diode D4 apply hysterises to avoid rapid charger cycling. Typically, the charger stops charging at approximately 15.4 volts and restarts at approximately 13.2 volts.

A trickle current is supplied to the batteries by the resistors R12 and R20. This current is about 17mA, safe for a single battery (worst case). If the battery voltage is very low (about 7 volts), then U1 pin 6 has a lower voltage than U1 pin 5, and pin 7 of U1 is high. Current flows through diode D1, keeping pin 2 of U1 at a voltage greater than pin 3, keeping the charger off.

Voltage regulator U2 provides a temperature-adjusted voltage (matching the temperature coefficient of the battery by using diodes D5, D6, and D7) for comparing with the battery voltage. Diode D9 prevents the battery from discharging through the charger circuit when no line power is available. The charger may be shut off by turning ON transistor Q7 from the CHGSHUTDWN line (connector J2 pin 6), which manipulates U1B in the same way as for a dead battery. The other part of the AB69A board carries the transformer and the switching transistor for the flyback for +,-12 volts, and -5 volts.

1.1.3 Power On/Off System. Please refer to schematic 185C187, sheet 1. Note connector P1 in the top left corner of the schematic. This connector receives rectified and filtered power from the power transformer and filter capacitor. The supply receives RAWPWR all the time, even when the front-panel switch is turned off. The current drain (from various ICs) is minimized to extend battery life.

The power is turned on and off by indirect means to allow an orderly shutdown by the Millennia processor when a turn-off is requested by the user. Shutdown commands may come from the following:

- Loss of keep-alive pulses.
- Turning OFF of the front-panel switch.
- Battery discharge.

The above listed items operate as follows:

The keep-alive arrangement allows the supply to run while a stream of pulses is received from the processor. If this stream ceases, either from a processor problem, or after an orderly shutdown, the power supply will time-out monostable, and control voltages inside the power supply will command the power-control ICs to turn off.

The keep-alive circuit performs the following:

a. Respond to a string of pulses to keep the power supply running.

b. Shuts off the power supply and beep if the string stops, except for:

1) Run unconditionally during the initial start-up time, except for when the front panel power switched is toggled to OFF (then the monitor shuts down immediately).

2) Does not shut down for any condition if the TEST switch SW1 is ON.

c. In the event of a keep-alive continuing after the front-panel switch is turned OFF, unconditionally stops the power supply after a short pause.

The keep-alive circuit consists of gate U2D, transistor Q29, monostables U1A and U1B, and their associated circuitry. The function of the circuit is to keep the power supply running as long as a series of pulses are received from the processor (these pulses are referred to as the "Keep-alive pulses").

Start up: When the front-panel switch is turned ON, a pulse is received into VSTY through resistor R32 and diodes D5 and D12. This pulse discharges C2 into the "A" inputs of both monos, starting them both. (Because STBY_15V is present, the monos and gate are ready to operate). Diode D47 clamps the pulse to no higher than the mono supply voltage; resistor R4 establishes the quiescent voltage on capacitor C2 before initial operation.

For the inital operation, while the processor is starting up, there will be no keep-alive pulses. The mono U1B has a long active interval (about 40 seconds), enough to keep the power supply running until keep-alive pulses are received. Its /Q output pulls resistor R2 and diode D1 LOW, and keeps the timing circuit on pin 2 of U1A low, thus keeping U1A in its active state. The outputs of U1A continue to control both supply switching ICs (U14 and U11) in the power-on condition. This situation is maintained until U1B times out, at which time, U1A must be receiving keep-alive pulses to continue in its active state. If the pulses are absent, U1A will quickly time out and the power supply will stop, as U14 and U11 will go into shutdown (having lost their enables).

The test switch SW1, if in its leftward position (ON), will hold the cathode of diode D1 low, and maintain mono U1A in its active state indefinitely. In this case, the power supply will stop only if power is removed by turning off the back-panel switch and removing the batteries, or by moving the TEST switch back to its rightward position (OFF).

The keep-alive pulses are received from pin 4 of connector P9. The transistor Q29 conditions the pulses for the larger logic swing required by gate U2 pin 13 (the U2 supply can go as high as 15 volts). Also, the input to transistor Q29 is AC-coupled, preventing the resting level of the keep-alive pulses from affecting the state of transistor Q29. Capacitor C88 provides the AC-coupling, resistor R5 is a protection resistor, capacitor C3 is a noise filter, diode D10 re-establishes the unidirectional swing at the base of transistor Q29, and resistor R35 discharges capacitor C3 to ensure that transistor Q29 is turned off when no pulses are received. Resistor R113 is the collector resistor for transistor Q29, and gate U2 pin 13 receives this string of pulses. As long as pin 12 is high, the string of pulses is passed through into mono U1A, keeping it active.

When the front-panel switch is turned OFF, the comparator U14 pin 4 (right side of schematic sheet 3) is pulled LOW through diode D24, taking the /UP_SHUTDOWN line LOW. This is a signal to the processor to immediately perform a shutdown routine and stop the keep-alive pulses. To over-ride the processor if it is in a loop, a shutdown signal also comes through transistors Q6 and Q5 (schematic sheet 3), turning off Q5, and causing gate U2 pin 12 to fall LOW after a delay established by resistor R34 and capacitor C97 (schematic sheet 1), and so blocking the keep-alive pulses from mono U1A.

In the event that the front-panel switch is turned OFF during mono U1B's 40-second start-up time, resistor R43 and capacitor C29 will pull U2 pin 13 low after a short delay, resetting U1B and, in conjunction with pin 12 of gate U2 (as described before), the mono U1A will quickly time out and shut down the power-control ICs.

Because the voltage on SWPWR may exceed the voltage on STDY_15, diode D15 clamps the voltage on U1B pin 13 to no more than the STDY_15 value. Resistor R44 limits the maximum D15 current. Diode D14 prevents a too-fast discharge of C29 when the front-panel switch is turned OFF. The diode D16 between SWPWR and U2 pin 6 squelches the power-fail beep during shutdown. So that the processor may control the actual shutdown, the voltage at VSTY is maintained through diode D4 from the +12V supply, keeping the keep-alive circuit able to run even after the front-panel switch is turned OFF.

If any event causes the power supply to shut down with the front-panel switch still ON, the gate U2C pin 8 raises its pin 10, turns on the local oscillator U2B and U2A, and produces a loud sound from the speaker under the batteries.

Low battery voltage will also shut down the power supply, if the warning /EARLY_WARN is ignored. If RAWPWR goes too low, the comparator U14 pin 8 goes low to effect this operation through transistor Q6 turning transistor Q5 OFF, as described above.

The transistor Q8 and its associated circuitry will be described in the section dealing with the battery indicator.

1.1.4 +5 and +3.3 Vdc Power Supplies. The +5V and +3.3V supplies are provided from U14 and the associated circuitry (on schematic sheet 3). U14 is a MAX786 chip, which is a synchronous-rectifier switcher. This design yields the greatest efficiency, as the rectifier for the energy discharge in the power inductor is now a switched FET with much lower voltage drop.

The description of the 5V supply will also suffice for the 3.3V section, with exceptions as noted. The input power to U14 is RAWPWR, and it is applied all the time that the power supply has an input voltage. Turn-on of U14 is done via the /SHDN pin brought HIGH. When U14 becomes active, the gate drive to transistor Q26 turns it ON. Transistor Q26 switches RAWPWR into the energy-storage inductor L10, causing the inductor current to ramp up, delivering current to the 5V devices on the 5V bus. After a period of time, transistor Q26 is turned OFF, and the stored energy in inductor L10 maintains its current as a decaying current ramp, with transistor Q17 supplying the current. Diode D37 passes current if Q17 is not ON when the transistor Q26 is turned OFF.

After some time, transistor Q17 is turned OFF, and transistor Q26 is turned ON to repeat the cycle. U14 adjusts the duty cycle of the transistors so that the output voltage is regulated. Because the gate of Q26 must swing volts above its source, which swings the full amount of the input power, U14 provides a bootstrapping action via pin 18 capacitively sensing the swing of the inductor through pin 17. Diode D38 acts as a rectifier pumping the Q17-drive voltage supply up to approximately five volts above the peak of the inductor swing. The drive from pin 16 then tracks the inductor waveform about five volts above it, allowing transistor Q26 to stay firmly ON as needed.

Current limiting is provided by controlling the voltage drop across R97, a low-value resistor, and the voltage-sensing for the regulation is into U14, pin 21.

The 3.3-V supply is similar, except that it has its own circuit section, including transistors Q24, Q18, and inductor L9. A similar bootstrapping is provided for this side, also. Current-limiting is done with resistor R96, and the voltage sense is into pin 1.

Diode D46's voltage drop provides a slightly higher output voltage for the five volt supply than U14 normally supplies, to overcome wiring voltage drops.

Capacitors C70 and C85 allow a soft start of U14; capacitor C27 bypasses the internal reference of U14; diode D14 clamps the highest turn-on voltage to a safe level for U14. Transistor Q30 is the local five-volt source for the bootstraps. Note that transistor Q30 is OFF if U14 is OFF.

The resistor R103 may be removed to put the three-volt section of U14 on standby, if there is no use for the three-volt supply. The three-volt supply will be used for motherboard power needs whenever three-volt processors are used.

1.1.5 +12 and -12 Vdc Supplies. Please refer to 185C187, sheet 2, and 185C197.

A flyback transformer (T1, on AB69A) supplies voltages used for analog functions. The operation cycle starts when power-control IC U11 is turned ON by mono U1A (pin 10 goes LOW). U11 delivers a drive pulse to the gate of transistor Q6 (on AB69A) that turns it ON; current from RAWPWR begins to flow in the transformer primary, storing magnetic energy in transformer T1's primary. At this time, none of the output rectifier diodes are conducting.

After a period of time, the drive to the gate of transistor Q6 is shut OFF, and it ceases conducting. A voltage spike occurs on transistor Q6's drain at this time (arising from the energy discharge of the leakage inductance of T1's primary). The rest of transformer T1's stored energy is available to the loads, and the rectifier diodes all turn on, delivering this energy to their various output capacitors until either all the stored energy in transformer T1 is dissipated, or transistor Q6 is turned on again.

After a period of time, transistor Q6 is turned ON again by U11, and the cycle repeats. Voltage feedback is provided from the +12V output through resistors R75 and R76 to regulate the +12V output; the other outputs approximate the 12V output according to their relative transformer turns ratios. Current limiting is provided by sensing the drop across resistor R22 (on AB69A) and comparing it with a voltage determined by resistors R39, R78, and R79 (all on AB69). Resistor R39 causes the in-limit current to reduce as the output loading increases further (limiting internal dissipation in the event of a dead short). This is called "fold-back" current limiting.

Op amp U4B amplifies the difference of the voltage sensed across resistor R22 and the voltage from the resistors R39, R78, and R79, and controls transistor Q11. When the current rises excessively, transistor Q11 conducts enough to pull U11 pin 9 LOW through diode D29 to reduce the duty cycle of the drive into transistor Q6, effectively reducing the output current from the supply. When the current limit is not effective, diode D29 is not conducting, and the voltage on U11 pin 9 is not affected.

Snubbers on the rectifier diodes D11 and D12 (both on AB69A) protect them from voltage spikes arising from the leakage inductance of the transformer. Diode D10 is comfortably enough below its voltage breakdown rating to not need a snubber; similarily, transistor Q6 is protected from damage by its avalanche capability.

1.1.6 Clock Generator. Please refer to 185C187, sheet 2.

The oscillator transistor Q27 operates from VSTY to accomplish the largest voltage swing. The crystal Y1 controls the oscillator's frequency and the output is delivered to the frequency dividers U10 and U6. The two divide-by-five sections of U10 are cascaded to deliver 320KHz to synchronize U14. A divide-by-two section then produces 160KHz to synchronize U11, and two further divide-by-two sections (part of U10 and half of U6) deliver 40KHz to the A/D board. An output of 4 MHz is taken from another divide-by-two (half of U6) for the A/D board.

1.1.7 NIBP Drivers. Please refer to 185C187, sheet 2.

The driver for the NIBP pump is taken through transistors Q23 and Q15. These are simultaneously turned ON or OFF by /PUMP_DRIVE operating through driver transistors Q12 and Q25. When /PUMP_DRIVE is LOW, the driver transistors are turned OFF, and the bases of transistors Q23 and Q15 are free to settle to voltages provided by resistors R60 for Q23, and R85 and R86 for Q15. Two transistors are used to reduce concentrated heating, and to increase reliability. Note that the base voltage of transistor Q23 will control its emitter voltage to slightly less than 12 volts, while the base voltage of transistor Q15 controls its emitter voltage to about 8 volts for the pump motor.

Current-limiting of the pump motor is provided by transistor Q13, which turns ON if the drop across resistor R89 increases beyond the emitter-base threshold voltage of transistor Q13 (this occurs at about two amperes through the pump motor). Also, the current is sensed by the op amp U13 and is available externally as PUMP_CUR_SENSE.

The dumpvalve is controlled by transistor Q14. Whenever there is no power or transistor Q14 is OFF, the dumpvalve is OPEN. The dumpvalve is closed by raising the DUMPVALVE drive voltage above ground.

When PVKILL goes HIGH, transistor Q28 conducts, and diodes D33, D34, and D32 on its collector conduct and pull LOW the gate and base drives to transistors Q14, Q23, and Q13, turning them OFF.

Also, transistor Q23's collector is wired externally to the output of the /OVER_PRESS_SW, so that, in the case of an overpressure action, the switch opens, the pump motor stops and the dumpvalve opens.

The linear bleed-down valve drive is provided by transistor Q16, as controlled by the op amp U13 receiving a linear signal from the A/D board.

1.1.8 Audio. Please refer to 185C187, sheet 1. Audio signals are provided by the audio amplifier U3. Outputs go to an external speaker; inputs come from the A/D board and from a local fail-signal oscillator U2B and U2A. Compensation and bypassing for U3 is provided by capacitors C22, C13, C11, and resistor R15. The output capacitor C12 blocks the DC quiescent voltage from the speaker.

The fail-signal oscillator is two sections of the gate U2 wired as a free-running oscillator. It is turned ON and OFF by the voltage into U2B pin 5. When the voltage is HIGH, the oscillator sounds through the speaker; otherwise, it is OFF. Transistor Q31 inverts the polarity and conditions the external FAIL_SOUND level from the A/D board (it comes in as a 5-volt logic level, and the U2 supply may be as high as 16 volts).

1.1.9 Power sense for POWER GOOD. Please refer to 185C187, sheet 1.

The op amp U4A provides the nucleus of the power-sense system. It compares the voltages between a divided-down sample of the five-volt reference from power-control IC U11 and the five- or

three-volt lines (selectable by jumpers). The circuit is a basic voltage comparator, with resistor R16 providing hysterises, and a threshold circuit for sensing sudden drops exceeding a few hundred millivolts. Capacitor C18 is charged to about half the sensed voltage by the shunting resistor R22 and resistors R23 and R30. If a sudden drop comes in that swings the negative terminal of C18 below one diode drop below the nominal voltage of 2.4 volts, the op amp output will swing negative and signal any power problems. Capacitor C15 performs a similar operation for the 3-volt supply, if the jumper is set accordingly. For a slow input drop, resistor R22 will cause the negative terminal of capacitor C18 to track the dropping input voltage, causing the threshold to be about 200mV down.

1.1.10 Battery/AC power sense. A bicolor LED on the front panel is driven by transistors Q2 and Q3 so that:

- AC Power present: LED is GREEN.
- No AC power, but batteries are OK: LED is YELLOW.
- Batteries getting LOW: LED is RED

When AC power is present, resistor R61 and diode D22 will keep the GREEN half of the LED lit, while transistor Q1's saturation will keep the base voltage to transistor Q3 low enough so that the RED half of the front-panel LED is OFF. When AC power fails, resistor R61 ceases to supply current to the GREEN half, and because transistor Q1 turns OFF (base drive is lost), transistor Q3's base will be pulled up by resistor R19, and Q3 supplies current to the RED half of the LED. As long as the battery is good, the /EARLY_WARN line will be HIGH, and transistor Q2 will be ON. Hence, the LED shows YELLOW (RED plus GREEN). When the /EARLY_WARN line goes low (active), transistor Q2 will turn OFF; because transistor Q3 is still ON, the LED will show RED.

When the fail-safe circuit is energized (power fails with the front-panel switch still ON), transistor Q8's gate is still high (the front-panel switch is still closed). Because gate U2C is now enabled (pin 8 is high), the high voltage from pin 10 is coupled into the base of transistor Q7, turning it on, and causing the GREEN LED drive to be diverted into the RED LED. Diode D22 increases the voltage across transistor Q7 to guarantee that all the current will be diverted into the RED LED. Note that transistor Q8 is wired as a source-follower to keep its substrate diode from conducting when the voltage on U2C pin 10 exceeds the base voltage of transistor Q7.

1.1.11 Recorder power. Please refer to 185C187, sheet 1. Transistor Q4 supplies recorder power regulated by its base voltage of 12 volts.

SECTION II

CALIBRATION AND VERIFICATION

2. CALIBRATION AND VERIFICATION

2.0 Required Test Equipment. The following test equipment is required to perform calibration and verification on the **Millennia™ Vital Signs Monitor**:

Digital Multimeter (DMM) (4.5 digit accuracy or better).
Manual Mercury Manometer.
Patient Simulator (ECG: 60-300 bpm, 0.5 to 2 mV amplitude, 1mV square wave at 2 Hz).
Pressure Simulator (0 to 250 mmHg).
Temperature Simulator (0 to 45°C).
Variable Autotransformer (50/60Hz, 120V input, 0-140V output or equivalent).
20 foot NIBP Hose.

2.0.1 Respiration Test Equipment. The following test equipment is only required if the monitor contains the Respiration option:

20 MHz Dual Channel Oscilloscope (Analog).
Patient Simulator (Respiration: 30 bpm, 0.1 to 3.0 Ohm impedance, baseline impedance 500 Ohm).

2.0.2 ETCO2 Test Equipment. The following test equipment is only required if the monitor contains the ETCO2 option:

Air Flow Meter (0 to 300 mL/minute)
Calibration Gas (10% CO2, 50% N2O, Balance N2, Invivo Research Part Number 9010F)

2.1 Set Up. Connect Line power of monitor to be tested to the autotransformer set to nominal line voltage for the respective model:

- 220VAC (nom line) - 220 VAC
- 117VAC (nom line) - 120 VAC
- 100VAC (nom line) - 100 VAC

2.1.1 Turning the Monitor On. Perform the following procedure to apply power to the monitor:

a. For AC Operation, verify that the AC Power Cord is plugged securely into line power and in the monitor's rear panel AC Power Connection. Verify that the LED Power Indicator (below the Rotary Knob) is illuminated Green.

b. Turn the front panel **POWER** switch to the ON position.

c. Verify that the **Millennia™ Vital Signs Monitor** Start Up Screen is displayed without any error messages before the Normal Screen is displayed.

d. Allow 15 minutes monitor warm-up time before performing any test or adjustment.

2.2 Front Panel Control Verification. (See Figure 2-1) Perform the following procedures to verify the proper operation of the Rotary Knob and Control Keys on the monitor front panel.

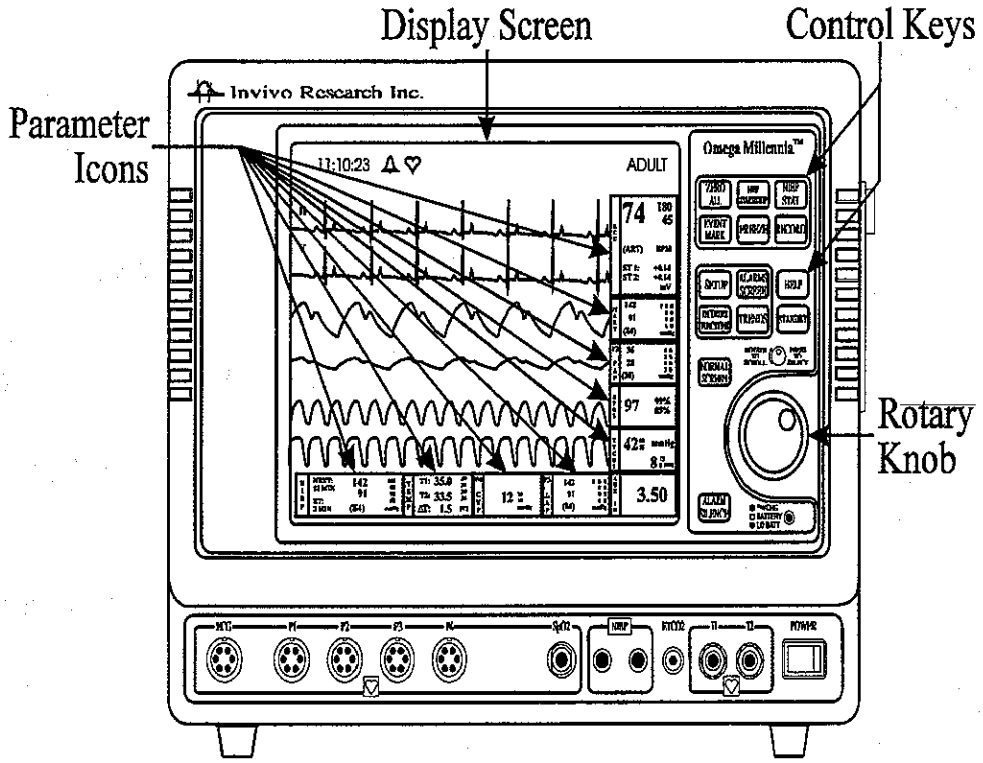

Figure 2-1. The Millennia™ Vital Signs Monitor Front Panel

2.2.1 Rotary Knob Verification. The Rotary Knob is located to the right of the Display Screen under the Control Keys. This knob performs two functions: rotating (turning) this knob allows the operator to "highlight" Parameter Icon's and, while in a menu, to "highlight" menu selections; pushing this knob allows the operator to select the "highlighted" icon or menu item. Perform the following procedure to verify proper operation of the Rotary Knob:

a. Rotate the knob in the clockwise direction while verifying that the highlight moves from icon to icon with a clockwise movement.

b. Rotate the knob in the counterclockwise direction while verifying that the highlight moves from icon to icon with a counterclockwise movement.

c. With any Parameter Icon highlighted, press the knob and verify that the Parameter Menu "comes up" on the Display Screen.

d. Rotate the knob in the clockwise direction while verifying that the highlight moves from selection to selection with a top to bottom movement.

e. Rotate the knob in the counterclockwise direction while verifying that the highlight moves from selection to selection with a bottom to top movement.

f. Highlight the **RETURN** menu item, press the knob and verify that the menu is removed from the Display Screen.

2.2.2 Control Key Verification. The Control Keys are located to the right of the Display Screen. Pressing a control key will open a function menu then, with the Rotary Knob, menu items may be selected and executed within the opened menu. Perform the following procedure to verify proper operation of the Control Keys:

a. Verify the **ZERO ALL** Control Key as follows:
   (1) Press the **SETUP** Control Key.
   (2) Turn the Rotary Knob to highlight the **DISPLAY SETUP** menu selection.
   (3) Press the Rotary Knob to select **DISPLAY SETUP**.
   (4) Turn the Rotary Knob to highlight the **TRACE C** menu selection.
   (5) Press the Rotary Knob to select **TRACE C**.
   (6) Turn the Rotary Knob to highlight **P1**.
   (7) Press the Rotary Knob to select **P1**.
   (8) Press the **NORMAL SCREEN** Control Key.
   (9) Press the **ZERO ALL** Control Key.
   (10) Observe that the monitor attempts to ZERO ALL the available pressure channels.
   (11) Use the Rotary Knob to highlight the **CANCEL** option and then press the knob.
   (11) Observe that the ZEROING display is removed.

b. Verify the **NIBP START/STOP** Control Key as follows:
   (1) Connect an NIBP Cuff to the **SENSE** and **INFLATE** Ports on the monitor front panel.
   (2) Press the **NIBP START/STOP** Control Key.
   (3) Observe that the monitor attempts to take an NIBP measurement.
   (4) Press the **NIBP START/STOP** Control Key.
   (5) Observe that the NIBP Pressure Pump turns off.

c. Verify the **NIBP STAT** Control Key as follows:
   (1) Press the **NIBP STAT** Control Key.
   (2) Observe that the monitor attempts to take an NIBP measurement.
   (3) Press the **NIBP START/STOP** Control Key.
   (4) Observe that the NIBP Pressure Pump turns off.

d. Verify the **FREEZE** Control Key as follows:
   (1) Press the **FREEZE** Control Key.
   (2) Observe that the display screen Trace A "Freezes" in Trace B location.
   (3) Press the **FREEZE** Control Key.
   (4) Observe that the display screen trace resumes its movement.

e. (If the Record option is installed) Verify the **RECORD** Control Key as follows:
   (1) Press the **RECORD** Control Key.
   (2) Observe that the printer (on the monitor side panel) begins to print.

(3) Press the **RECORD** Control Key.

(4) Observe that the printout is aborted (this is not immediately apparent as a Patient Information Area is printed before the printer actually stops.

f. Verify the **SETUP** Control Key as follows:

(1) Press the **SETUP** Control Key.

(2) Observe that the **SETUPS** Menu is displayed.

(3) Press the **NORMAL SCREEN** Control Key.

(4) Observe that the **SETUPS** Menu is removed from the display.

g. Verify the **ALARMS SCREEN** Control Key as follows:

(1) Press the **ALARMS SCREEN** Control Key.

(2) Observe that the **ALARMS** Menu is displayed.

(3) Press the **NORMAL SCREEN** Control Key.

(4) Observe that the **ALARMS** Menu is removed from the display.

h. Verify the **HELP** Control Key as follows

(1) Press the **HELP** Control Key.

(2) Observe that the **Help Screen** is displayed.

(3) Press the **NORMAL SCREEN** Control Key.

(4) Observe that the **Help Screen** is removed from the display.

i. (If the Record option is installed) Verify the **RECORDER FUNCTIONS** Control Key as follows:

(1) Press the **RECORDER FUNCTIONS** Control Key.

(2) Observe that the **RECORDER** Menu is displayed.

(3) Press the **NORMAL SCREEN** Control Key.

(4) Observe that the **RECORDER** Menu is removed from the display.

j. Verify the **TRENDS** Control Key as follows:

(1) Press the **TRENDS** Control Key.

(2) Observe that the **HISTORY** Menu is displayed.

(3) Press the **NORMAL SCREEN** Control Key.

(4) Observe that the **HISTORY** Menu is removed from the display.

k. Verify the **STANDBY** Control Key as follows:

(1) Press the **STANDBY** Control Key.

(2) Observe that **STANDBY** is displayed in the middle of the display screen.

(3) Press the **STANDBY** Control Key.

(4) Observe that the **STANDBY** message is removed from the display screen.

2.3 Low and High Line Verification. This monitor has been designed to operate with AC Line fluctuations plus or minus 10%. Perform the following procedure to ensure proper operation of the monitor in Low or High Line Power situations:

a. **Low Line Verification.** Perform the following procedure to verify proper operation of the monitor in a Low Line Power situation:

(1) Set the Autotransformer for your respective monitor:

100V models, 89VAC ±1.0VAC
120V models, 107VAC ±1.0VAC
220V models, 197VAC ±1.0VAC
240V models, 215VAC ±1.0VAC

(2) Turn on all the parameters and verify that the monitor continues to function normally.

(3) Turn off all the parameters.

b. **High Line Verification.** Perform the following procedure to verify proper operation of the monitor in a High Power situation:

(1) Set the Autotransformer for your respective monitor:

100V models, 111VAC ± 1.0VAC
120V models, 133VAC ± 1.0VAC
220V models, 243VAC ± 1.0VAC
240V models, 265VAC ± 1.0VAC

(2) Turn on all the parameters and verify that the monitor continues to function normally.

(3) Turn off all the parameters.

c. Return the autotransformer to a nominal line voltage.

2.4 Sound System Verification and Adjustment. Perform the following procedure to verify and adjust the volume level of the Alarm Tone, Pulse Tone or the Click Tone:

a. Access the **SOUND ADJUST** Menu as follows:

(1) Press the **SETUP** Control Key.

(2) Use the Rotary Knob to highlight the **SOUND ADJUST** menu selection.

(3) Press the Rotary Knob.

b. Verify and adjust the Alarm Tone Volume as follows:

(1) Use the Rotary Knob to highlight the **ALARM VOLUME** menu selection.

(2) Press the Rotary Knob.

(3) Use the Rotary Knob to highlight the various Volume settings, pressing the knob at each one to verify that the volume level changes.

(4) Use the Rotary Knob to highlight 5.

(5) Press the Rotary Knob.

(6) Scroll to the **DONE** menu selection and press the Rotary Knob.

c. Verify and adjust the Pulse Tone Volume as follows:

(1) Use the Rotary Knob to highlight the **PULSE VOLUME** menu selection.

(2) Press the Rotary Knob.

(3) Use the Rotary Knob to highlight the various Volume settings, pressing the knob at each one to verify that the volume level changes.

(4) Use the Rotary Knob to highlight 3.

(5) Press the Rotary Knob.

(6) Scroll to the **DONE** menu selection and press the Rotary Knob.

d. Verify and adjust the Click Tone Volume as follows:

(1) Use the Rotary Knob to highlight the **CLICK VOLUME** menu selection.

(2) Press the Rotary Knob.

(3) Use the Rotary Knob to highlight the various Volume settings, pressing the knob at each one to verify that the volume level changes.

(4) Use the Rotary Knob to highlight 3.

(5) Press the Rotary Knob.

(6) Scroll to the **DONE** menu selection and press the Rotary Knob.

e. Exit by pressing the **NORMAL SCREEN** Control Key.

2.5 Time Set Verification. Perform the following procedure to verify and adjust the Time Setting of this monitor.

a. Press the **SETUP** Control Key.

b. Use the Rotary Knob to highlight the **SET TIME** menu selection.

c. Press the Rotary Knob to select the **SET TIME** Menu.

d. Verify the 12 and 24 hour clocks as follows:

(1) Turn the Rotary Knob to highlight the **FORMAT** menu selection.

(2) Press the Rotary Knob to select **FORMAT**.

(3) Turn the Rotary Knob to toggle the clock from 12 to 24 hour while observing that the **HOUR** menu selection also toggles to reflect the format change.

(4) Turn the Rotary Knob until the desired setting is displayed then press the knob to accept the setting.

e. Verify the Seconds adjustment as follows:

(1) Turn the Rotary Knob to highlight the **SECOND** menu selection.

(2) Press the Rotary Knob to select **SECOND**.

(3) Turn the Rotary Knob until the correct **SECOND** is displayed.

(4) Press the Rotary Knob to accept the **SECOND** setting.

f. Verify the Minutes adjustment as follows:

(1) Turn the Rotary Knob to highlight the **MINUTE** menu selection.

(2) Press the Rotary Knob to select **MINUTE**.

(3) Turn the Rotary Knob until the correct **MINUTE** is displayed.

(4) Press the Rotary Knob to accept the **MINUTE** setting.

g. Verify the Hours adjustment as follows:

(1) Turn the Rotary Knob to highlight the **HOUR** menu selection.
(2) Press the Rotary Knob to select **HOUR**.
(3) Turn the Rotary Knob until the correct **HOUR** is displayed.
(4) Press the Rotary Knob to accept the **HOUR** setting.

h. Verify the Day adjustment as follows:

(1) Turn the Rotary Knob to highlight the **DAY** menu selection.
(2) Press the Rotary Knob to select **DAY**.
(3) Turn the Rotary Knob until the correct **DAY** is displayed.
(4) Press the Rotary Knob to accept the **DAY** setting.

i. Verify the Month adjustment as follows:

(1) Turn the Rotary Knob to highlight the **MONTH** menu selection.
(2) Press the Rotary Knob to select **MONTH**.
(3) Turn the Rotary Knob until the correct **MONTH** is displayed.
(4) Press the Rotary Knob to accept the **MONTH** setting.

j. Verify the Year adjustment as follows:

(1) Turn the Rotary Knob to highlight the **YEAR** menu selection.
(2) Press the Rotary Knob to select **YEAR**.
(3) Turn the Rotary Knob until the correct **YEAR** is displayed.
(4) Press the Rotary Knob to accept the **YEAR** setting.

k. Turn the Rotary Knob to highlight the **ENTER** menu selection.

l. Press the Rotary Knob to save the changes performed.

m. Turn the Rotary Knob to highlight the **RETURN** menu selection.

n. Press the Rotary Knob to return to the **SETUPS** Menu.

o. Press the **NORMAL SCREEN** Control Key to return the monitor to the operational display.

2.6 Store and Recall Setups. Perform the following procedure to verify the proper operation of the Store and Recall Setups feature (performing this test may change all stored setups):

a. Press the **SETUP** Control Key.

b. Turn the Rotary Knob to highlight the **PARAMETER** menu selection.

c. Press the Rotary Knob to select **PARAMETER**.

d. Turn the Rotary Knob to highlight the **TEMP** selection.

e. Press the Rotary Knob to select **TEMP.**

f. Turn the Rotary Knob to highlight the **ON** menu selection.

g. Press the Rotary Knob to select **ON**.

h. Press the **SETUP** Control Key.

i. Turn the Rotary Knob to select the **STORE SETUPS** menu selection.

j. Press the Rotary Knob to select **STORE SETUPS**.

k. Turn the Rotary Knob to highlight the **A** menu selection.

l. Press the Rotary Knob to select **A**.

m. Turn the Rotary Knob to highlight the **YES** menu selection.

n. Press the Rotary Knob to select **YES**.

o. Turn the front panel power switch Off, wait 5 seconds and then turn the front panel power switch On.

p. Once the Normal Screen appears, press the **SETUP** Control Key.

q. Turn the Rotary Knob to highlight the **RECALL SETUPS** menu selection.

r. Press the Rotary Knob to select **RECALL SETUPS**.

s. Turn the Rotary Knob to highlight the **A** menu selection.

t. Press the Rotary Knob to select **A**.

u. Turn the Rotary Knob to highlight the **YES** menu selection.

v. Press the Rotary Knob to select **YES**.

w. Verify the presence of the **TEMP** window in the lower display.

2.6.1 Cold Start Verification. Perform the following procedure to verify the proper operation of the Cold Start feature:

a. Turn the front panel power switch Off.

b. Press and hold the Rotary Knob while turning the front panel power switch to On.

c. When the display screen flashes white (in approximately 3 seconds), release the Rotary Knob then press and hold the **HELP** Control Key.

d. When the Cold Start message appears on the lower left of the screen, release the **HELP** Control Key.

e. Press the **SETUP** Control Key.

f. Turn the Rotary Knob to highlight the **RECALL SETUPS** menu selection.

g. Press the Rotary Knob to select **RECALL SETUPS**.

h. Turn the Rotary Knob to highlight the **A** menu selection.

i. Press the Rotary Knob to select **A**.

j. Turn the Rotary Knob to highlight the **YES** menu selection.

k. Press the Rotary Knob to select **YES**.

l. Verify Cold Start by the absence of TEMP window in the lower display screen.

2.7 Invasive Pressure Verification. (If the Invasive Pressure option is installed) Perform the following procedure to verify the proper operation of the Invasive Pressure monitoring system:

a. Connect the output of a Pressure Simulator to the P1 connector on the monitor front panel.

b. Set the Pressure Simulator to output 000 mmHg with the Zero switch on.

c. Turn on P1 as follows:

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **PARAMETER SELECTION** menu selection.

(3) Press the Rotary Knob to select **PARAMETER SELECTION**.

(4) Turn the Rotary Knob to highlight the **P1** parameter selection.

(5) Press the Rotary Knob to select **P1.**

(6) Turn the Rotary Knob to highlight the **ON** menu selection.

(7) Press the Rotary Knob to select **ON**.

(8) Press the **NORMAL SCREEN** Control Key.

d. Setup Invasive Pressure 1 as follows:

(1) Turn the Rotary Knob to highlight the P1 Icon.

(2) Press the Rotary Knob to bring up the **P1** Menu.

(3) Press the Rotary Knob to select the **ZERO SET** menu selection.

(4) Verify successful zeroing of Pressure Channel 1.

(5) Press the Rotary Knob to select OK.

e. Verify the P1 numerics indicate Zero ±1 count.

f. Press the **NORMAL SCREEN** Control Key.

g. Adjust the Pressure Simulator as follows:

(1) Set the Pressure Simulator Zero switch to "+."

(2) Set the Pressure Simulator to output 240.

h. Verify that the P1 numerics increase in a positive direction toward 240.

i. Set the Pressure Simulator Zero switch to Zero.

j. Verify that the P1 numerics return to zero.

k. Verify the Invasive Pressure at different levels as follows:

(1) Set the Pressure Simulator Zero switch to "+."

(2) Set the Pressure Simulator to output 50.

(3) Verify that the P1 numerics indicate 50 ±1.

(4) Set the Pressure Simulator to output 100.
(5) Verify that the P1 numerics indicate 100 ±1.
(6) Set the Pressure Simulator to output 150.
(7) Verify that the P1 numerics indicate 150 ±1.
(8) Set the Pressure Simulator to output 200.
(9) Verify that the P1 numerics indicate 200 ±2.
(10) Set the Pressure Simulator to output 240.
(11) Verify that the P1 numerics indicate 240 ±2.
(12) Set the Pressure Simulator to output 250.
(13) Verify that the P1 numerics indicate 250 alternated with the **OVR** message.

l. (If P2, P3 and P4 options are installed) Repeat substeps a through j for P2, P3 and P4 as required.

2.8 Recorder Verification. (If the Recorder option is installed) Perform the following procedure to verify proper operation of the monitors printing system:

a. Connect a ECG Patient Simulator to the ECG input on the monitor front panel.

b. Set the Patient Simulator to output a 1 mV square wave at 2 Hz.

c. Setup the ECG as follows:
(1) Turn the Rotary Knob to highlight the ECG Icon.
(2) Press the Rotary Knob to bring up the **ECG** Menu.
(3) Turn the Rotary Knob to highlight the **TRACE A LEAD** menu selection.
(4) Press the Rotary Knob to select **TRACE A LEAD**.
(5) Turn the Rotary Knob to highlight the **LEAD II** menu selection.
(6) Press the Rotary Knob to select **LEAD II**.
(7) If Dual Lead ECG is installed, perform the following:
(a) Turn the Rotary Knob to highlight the **TRACE B LEAD** menu selection.
(b) Press the Rotary Knob to select **TRACE B LEAD**.
(c) Turn the Rotary Knob to highlight the **LEAD II** menu selection.
(d) Press the Rotary Knob to select **LEAD II**.
(8) Turn the Rotary Knob to highlight the **FILTER MODE** menu selection.
(9) Press the Rotary Knob to bring up the **FILTER MODE** Menu.
(10) Turn the Rotary Knob to highlight the **DIAG** menu selection.
(11) Press the Rotary Knob to select **DIAG**.
(12) Turn the Rotary Knob to highlight the **SCALE** menu selection.
(13) Press the Rotary Knob to bring up the **SCALE** Menu.
(14) Turn the Rotary Knob to highlight the **10 mm/mV** menu selection.
(15) Press the Rotary Knob to select **10 mm/mV**.

d. Setup the Recorder as follows:
   (1) Press the **RECORDER FUNCTIONS** Control Key.
   (2) Turn the Rotary Knob to highlight the **TRACE 1** menu selection.
   (3) Press the Rotary Knob to select **TRACE 1.**
   (4) Turn the Rotary Knob to highlight the **ECG 1** menu selection.
   (5) Press the Rotary Knob to select **ECG 1.**
   (6) Turn the Rotary Knob to highlight the **TRACE 2** menu selection.
   (7) Press the Rotary Knob to select **TRACE 2.**
   (8) Turn the Rotary Knob to highlight the **OFF** menu selection.
   (9) Press the Rotary Knob to select **OFF.**
   (10) Turn the Rotary Knob to highlight the **SWEEP SPEED** menu selection.
   (11) Press the Rotary Knob to select **SWEEP SPEED.**
   (12) Turn the Rotary Knob to highlight the **25 mm/s** menu selection.
   (13) Press the Rotary Knob to select **25 mm/s.**

e. Press the **RECORD** Control Key, wait five (5) seconds and press the **RECORD** Control Key a second time.

f. Verify the following:
   (1) The paper comes out smoothly with all printing performed clearly.
   (2) The printout has a deflection of 10 mm (2 blocks) ±1mm.
   (3) Verify that the LO speed printout is a full cycle of 15 mm (2.5 blocks) ±1 mm.

g. Setup the Recorder as follows:
   (1) Press the **RECORDER FUNCTIONS** Control Key.
   (2) Turn the Rotary Knob to highlight the **SWEEP SPEED** menu selection.
   (3) Press the Rotary Knob to select **SWEEP SPEED.**
   (4) Turn the Rotary Knob to highlight the **50 mm/s** menu selection.
   (5) Press the Rotary Knob to select **50 mm/s.**

h. Press the **RECORD** Control Key, wait five (5) seconds and press the **RECORD** Control Key a second time.

i. Verify that the HI speed printout is a full cycle of 30 mm (5 blocks) ±1 mm.

Perform Substeps j through o if the Dual Trace ECG option is installed.

j. Setup the Recorder as follows:
   (1) Press the **RECORDER FUNCTIONS** Control Key.
   (2) Turn the Rotary Knob to highlight the **TRACE 1** menu selection.
   (3) Press the Rotary Knob to select **TRACE 1.**
   (4) Turn the Rotary Knob to highlight the **ECG 2** menu selection.
   (5) Press the Rotary Knob to select **ECG 2.**

(6) Turn the Rotary Knob to highlight the **SWEEP SPEED** menu selection.
(7) Press the Rotary Knob to select **SWEEP SPEED**.
(8) Turn the Rotary Knob to highlight the **25 MM/S** menu selection.
(9) Press the Rotary Knob to select **25 MM/S**.

k. Press the **RECORD** Control Key, wait five (5) seconds and press the **RECORD** Control Key a second time.

l. Verify the following:
(1) The paper comes out smoothly with all printing performed clearly.
(2) The printout has a deflection of 10 mm (2 blocks) ±1mm.
(3) Verify that the LO speed printout is a full cycle of 15 mm (2.5 blocks) ±1 mm.

m. Setup the Recorder as follows:
(1) Press the **RECORDER FUNCTIONS** Control Key.
(2) Turn the Rotary Knob to highlight the **SWEEP SPEED** menu selection.
(3) Press the Rotary Knob to select **SWEEP SPEED**.
(4) Turn the Rotary Knob to highlight the **50 mm/s** menu selection.
(5) Press the Rotary Knob to select **50 mm/s**.

n. Press the **RECORD** Control Key, wait five (5) seconds and press the **RECORD** Control Key a second time.

o. Verify that the HI speed printout is a full cycle of 30 mm (5 blocks) ±1 mm.

p. Setup the Recorder as follows:
(1) Press the **RECORDER FUNCTIONS** Control Key.
(2) Turn the Rotary Knob to highlight the **SWEEP SPEED** menu selection.
(3) Press the Rotary Knob to select **SWEEP SPEED**.
(4) Turn the Rotary Knob to highlight the **25 mm/s** menu selection.
(5) Press the Rotary Knob to select **25 mm/s**.

q. Press the **NORMAL SCREEN** Control Key.

r. Disconnect the Patient Simulator from the monitor front panel.

2.9 ECG Verification. Perform the following procedure to verify proper operation of the ECG system:

a. Connect a ECG Patient Simulator to the ECG input on the monitor front panel.

b. Set the Patient Simulator to output a 0.5mV QRS pulse at 60BPM'S (NORMAL SINUS mode).

c. Setup the ECG as follows:
(1) Turn the Rotary Knob to highlight the ECG Icon.
(2) Press the Rotary Knob to bring up the **ECG** Menu.
(3) Turn the Rotary Knob to highlight the **TRACE A LEAD** menu selection.

(4) Press the Rotary Knob to select **TRACE A LEAD**.
(5) Turn the Rotary Knob to highlight the **LEAD II** menu selection.
(6) Press the Rotary Knob to select **LEAD II**.
(7) If Dual Lead ECG is installed, perform the following:
  (a) Turn the Rotary Knob to highlight the **TRACE B LEAD** menu selection.
  (b) Press the Rotary Knob to select **TRACE B LEAD**.
  (c) Turn the Rotary Knob to highlight the **OFF** menu selection.
  (d) Press the Rotary Knob to select **OFF**.
(8) Turn the Rotary Knob to highlight the **FILTER MODE** menu selection.
(9) Press the Rotary Knob to bring up the **FILTER MODE** Menu.
(10) Turn the Rotary Knob to highlight the **DIAG** menu selection.
(11) Press the Rotary Knob to select **DIAG**.
(12) Turn the Rotary Knob to highlight the **SCALE** menu selection.
(13) Press the Rotary Knob to bring up the **SCALE** Menu.
(14) Turn the Rotary Knob to highlight the **10 mm/mV** menu selection.
(15) Press the Rotary Knob to select **10 mm/mV**.
(16) Turn the Rotary Knob to highlight the **HR TONE SRCE** menu selection.
(17) Press the Rotary Knob to bring up the **HR TONE SRCE** Menu.
(18) Turn the Rotary Knob to highlight the **QRS** menu selection.
(19) Press the Rotary Knob to select **QRS**.
(20) Press the **NORMAL SCREEN** Control Key.

d. Verify the following:
  (1) Trace A shows a waveform train of moving QRS pulses without jittering.
  (2) Trace A numerics indicate an ECG count of 60 BPM.
  (3) The QRS Symbol (flashing heart) is present.
  (4) QRS Heart Rate Tone is present with NO double tones.

e. Set the Patient Simulator to output a 2 mV QRS pulse at 60BPM'S.

f. Verify the following:
  (1) Trace A shows a waveform train of moving QRS pulses without jittering.
  (2) Trace A numerics indicate an ECG count of 60 BPM.
  (3) The QRS Symbol (flashing heart) is present.
  (4) QRS Heart Rate Tone is present with NO double tones.

g. Repeat substep f. for all Leads except for CAL.

h. Set the Patient Simulator to output a 2 mV QRS pulse at 120BPM's.

i. Verify the following:
  (1) Trace A shows a waveform train of moving QRS pulses without jittering.

(2) Trace A numerics indicate an ECG count of 120 BPM.
(3) The QRS Symbol (flashing heart) is present.
(4) QRS Heart Rate Tone is present with NO double tones.

j. Repeat substep i. for all Leads except for CAL.

k. Set the Patient Simulator to output a 2 mV QRS pulse at 240 BPM's.

l. Verify the following:
(1) Trace A shows a waveform train of moving QRS pulses without jittering.
(2) Trace A numerics indicate an ECG count of 240 BPM.
(3) The QRS Symbol (flashing heart) is present.
(4) QRS Heart Rate Tone is present with NO double tones.

m. Repeat substep l. for all Leads except for CAL.

n. Set the Patient Simulator to output a 2 mV QRS pulse at 300 BPM's.

o. Verify all Leads display "**OVR**."

p. Turn the Rotary Knob to highlight the **RETURN** menu selection.

q. Press the Rotary Knob to select **RETURN**.

r. Turn the Rotary Knob to highlight the **CAL** menu selection.

s. Press the Rotary Knob to select **CAL**.

t. Press and hold the Rotary Knob.

u. When the waveform stabilized, verify an ECG count of 146 ±1.

v. Release the Rotary Knob.

Perform substeps w and x is the Recorder option is installed.

w. Press the **RECORD** Control Key, wait five (5) seconds and press the **RECORD** Control Key a second time.

x. Verify that the printout has a deflection of 10mm (2 blocks) ±1mm.

y. Disconnect the Patient Simulator from the monitor front panel.

2.9.1 ECG Lead Fail Verification. Perform the following procedure to verify proper operation of the ECG Lead Fail Circuitry:

a. Connect a ECG Patient Simulator to the ECG input on the monitor front panel.

b. Set the Patient Simulator to output a 1.0 mV QRS pulse at 60BPM'S (NORMAL SINUS mode).

c. Select ECG Lead I.

d. Remove one wire at a time (that pertains to the selected lead) until all the Lead Wires have been tested. In each case verify that **within 25 seconds** of removal of each wire that the "**LEAD FAIL**" message appears to the right of the selected lead at the top left of the

display screen and that there is no QRS Tone or Number displayed. Verify that the trace recovery time is within 25 seconds of Lead Fail Correction.

e. Select each lead in order and perform substep d. until all the leads (except CAL) have been verified.

f. Disconnect the Patient Simulator from the monitor front panel.

2.9.2 ECG Neonate Lead Fail Verification. Perform the following procedure to verify proper operation of the ECG Neonatal Lead Fail Circuitry:

a. Connect a ECG Patient Simulator to the ECG input on the monitor front panel.

b. Set the Patient Simulator to output a 0.5 mV QRS pulse at 60BPM'S (NORMAL SINUS mode).

c. Select ECG Lead III as follows:
   (1) Turn the Rotary Knob to highlight the ECG Icon.
   (2) Press the Rotary Knob to bring up the **ECG** Menu.
   (3) Turn the Rotary Knob to highlight the **TRACE A LEAD** menu selection.
   (4) Press the Rotary Knob to select **TRACE A LEAD**.
   (5) Turn the Rotary Knob to highlight the **LEAD III** menu selection.
   (6) Press the Rotary Knob to select **LEAD III**.

d. Verify that, while still in Adult Mode, there is no QRS Tone or Number displayed and the **ASYSTOLE** message is displayed in the ECG message area.

e. Change the Patient Mode as follows:
   1) Press the **SETUP** Control Key.
   2) Turn the Rotary Knob to highlight the **PATIENT** menu selection.
   3) Press the Rotary Knob to select **PATIENT**.
   4) Turn the Rotary Knob to highlight the **NEO** menu selection.
   5) Press the Rotary Knob to select **NEO**.
   6) Press the **NORMAL SCREEN** Control Key.

f. Verify a QRS count of "60," a flashing heart symbol and audible tone, and no **LEAD FAIL** message in the ECG message area.

g. Remove one wire at a time (that pertains to the selected lead) until all the Lead Wires have been tested. In each case verify that **within 25 seconds** of removal of each wire that the "**LEAD FAIL**" message appears to the right of the selected lead at the top left of the display screen and that there is no QRS Tone or Number displayed. Verify that the trace recovery time is within 25 seconds of Lead Fail Correction.

h. Change the Patient Mode as follows:
   1) Press the **SETUP** Control Key.
   2) Turn the Rotary Knob to highlight the **PATIENT** menu selection.
   3) Press the Rotary Knob to select **PATIENT**.

4) Turn the Rotary Knob to highlight the **ADULT** menu selection.
5) Press the Rotary Knob to select **ADULT**.
6) Press the **NORMAL SCREEN** Control Key.

i. Disconnect the Patient Simulator from the monitor front panel.

2.9.3 Dual ECG Verification. (If the Dual ECG option is installed) Perform the following procedure to verify proper operation of the Dual Lead ECG system:

a. Connect a ECG Patient Simulator to the ECG input on the monitor front panel.

b. Set the Patient Simulator to output a 0.5 mV QRS pulse at 60BPM'S (NORMAL SINUS mode).

c. Setup the ECG as follows:
(1) Turn the Rotary Knob to highlight the ECG Icon.
(2) Press the Rotary Knob to bring up the **ECG** Menu.
(3) Turn the Rotary Knob to highlight the **TRACE A LEAD** menu selection.
(4) Press the Rotary Knob to select **TRACE A LEAD**.
(5) Turn the Rotary Knob to highlight the **OFF** menu selection.
(6) Press the Rotary Knob to select **OFF**.
(7) Turn the Rotary Knob to highlight the **TRACE B LEAD** menu selection.
(8) Press the Rotary Knob to select **TRACE B LEAD**.
(9) Turn the Rotary Knob to highlight the **LEAD II** menu selection.
(10) Press the Rotary Knob to select **LEAD II**.
(11) Turn the Rotary Knob to highlight the **FILTER MODE** menu selection.
(12) Press the Rotary Knob to bring up the **FILTER MODE** Menu.
(13) Turn the Rotary Knob to highlight the **DIAG** menu selection.
(14) Press the Rotary Knob to select **DIAG**.
(15) Turn the Rotary Knob to highlight the **SCALE** menu selection.
(16) Press the Rotary Knob to bring up the **SCALE** Menu.
(17) Turn the Rotary Knob to highlight the **10 mm/mV** menu selection.
(18) Press the Rotary Knob to select **10 mm/mV**.
(19) Turn the Rotary Knob to highlight the **HR TONE SRCE** menu selection.
(20) Press the Rotary Knob to bring up the **HR TONE SRCE** Menu.
(21) Turn the Rotary Knob to highlight the **QRS** menu selection.
(22) Press the Rotary Knob to select **QRS**.
(23) Press the **NORMAL SCREEN** Control Key.

d. Verify the following:
(1) An ECG count of 60 bpm on Lead II, QRS waveform and the flashing heart symbol are present.
(2) Trace B displays a waveform train of moving QRS pulses with no jittering.

(3) QRS Heart Rate Tone is present with NO double tones.

e. Set the Patient Simulator to output a 2 mV QRS pulse at 60BPM'S.

f. Verify the following:

(1) Trace B shows a waveform train of moving QRS pulses without jittering.

(2) Trace B numerics indicate an ECG count of 60 BPM.

(3) The QRS Symbol (flashing heart) is present.

(4) QRS Heart Rate Tone is present with NO double tones.

g. Repeat substep f. for all Leads except for CAL.

h. Set the Patient Simulator to output a 2 mV QRS pulse at 120BPM's.

i. Verify the following:

(1) Trace B shows a waveform train of moving QRS pulses without jittering.

(2) Trace B numerics indicate an ECG count of 120 BPM.

(3) The QRS Symbol (flashing heart) is present.

(4) QRS Heart Rate Tone is present with NO double tones.

j. Repeat substep i. for all Leads except for CAL.

k. Set the Patient Simulator to output a 2 mV QRS pulse at 240 BPM's.

l. Verify the following:

(1) Trace B shows a waveform train of moving QRS pulses without jittering.

(2) Trace B numerics indicate an ECG count of 240 BPM.

(3) The QRS Symbol (flashing heart) is present.

(4) QRS Heart Rate Tone is present with NO double tones.

m. Repeat substep l. for all Leads except for CAL.

n. Set the Patient Simulator to output a 2 mV QRS pulse at 300 BPM's.

o. Verify all Leads display **"OVR."**

p. Setup the Recorder as follows:

(1) Press the **RECORDER FUNCTIONS** Control Key.

(2) Turn the Rotary Knob to highlight the **TRACE 1** menu selection.

(3) Press the Rotary Knob to select **TRACE 1.**

(4) Turn the Rotary Knob to highlight the **ECG 2** menu selection.

(5) Press the Rotary Knob to select **ECG 2.**

q. Turn the Rotary Knob to highlight the **ECG** icon.

r. Press the Rotary Knob to select the **ECG** menu.

s. Turn the Rotary Knob to highlight the **CAL** menu selection.

t. Press the Rotary Knob to select **CAL**.

u. Press and hold the Rotary Knob.

v. When the waveform stabilized, verify an ECG count of 146 ±1.

w. Release the Rotary Knob.

x. Press the **RECORD** Control Key, wait five (5) seconds and press the **RECORD** Control Key a second time.

y. Verify that the printout has a deflection of 10 mm (2 blocks) ±1 mm.

z. Press the **NORMAL SCREEN** Control Key.

aa. Disconnect the Patient Simulator from the monitor front panel.

2.10 ST Segment Verification. Perform the following to verify proper operation of the ST Segment system:

a. Turn the Rotary Knob to highlight the **ECG** icon.

b. Press the Rotary Knob to select the **ECG** menu.

c. Turn the Rotary Knob to highlight the **TRACE A LEAD** menu selection.

d. Press the Rotary Knob to select **TRACE A LEAD**.

e. Turn the Rotary Knob to highlight the **II** menu selection.

f. Press the Rotary Knob to select lead **II**.

g. Turn the Rotary Knob to highlight the **TRACE B LEAD** menu selection.

h. Press the Rotary Knob to select **TRACE B LEAD**.

i. Turn the Rotary Knob to highlight the **II** menu selection.

j. Press the Rotary Knob to select lead **II**.

k. Turn the Rotary Knob to highlight the **ST DISPLAY** menu selection.

l. Press the Rotary Knob to select **ST DISPLAY**.

m. Turn the Rotary Knob to highlight the **ON** menu selection.

n. Press the Rotary Knob to turn the ST Segment Display **ON**.

o. Set Patient Simulator to 1 mV, 60 bpm with ST On, POS at 0.8 setting.

p. Verify ST reading of +0.80 (±0.05) in ST1 and ST2.

2.11 Respiration Verification. Perform the following to verify proper operation of the Respiration system:

a. Connect a Patient Simulator to the ECG input on the monitor front panel.

b. Set the Patient Simulator respiration to 30 bpm at 3.0 Ohms impedance with baseline impedance of 500 Ohms.

c. Set APNEA to OFF on the Patient Simulator.

d. Setup Respiration as follows:
   (1) Press the **SETUP** Control Key.
   (2) Turn the Rotary Knob to highlight the **DISPLAY SETUP** menu selection.
   (3) Press the Rotary Knob to select **DISPLAY SETUP**.
   (4) Turn the Rotary Knob to highlight the **TRACE C** selection.
   (5) Press the Rotary Knob to select **TRACE C**.
   (6) Turn the Rotary Knob to highlight the **RESP** menu selection.
   (7) Press the Rotary Knob to select **RESP**.
   (8) Turn the Rotary Knob to highlight the **RETURN** menu selection.
   (9) Press the Rotary Knob to select **RETURN**.
   (10) Turn the Rotary Knob to highlight the **RESP SPEED** menu selection.
   (11) Press the Rotary Knob to select **RESP SPEED**.
   (12) Turn the Rotary Knob to highlight the **12.5 mm/s** menu selection.
   (13) Press the Rotary Knob to select **12.5 mm/s**.
   (14) Press the **NORMAL SCREEN** Control Key.
   (15) Turn the Rotary Knob to highlight the **RESP** icon.
   (16) Press the Rotary Knob to select the **RESP** menu.
   (17) Turn the Rotary Knob to highlight the **SIZE** menu selection.
   (18) Press the Rotary Knob to select **SIZE**.
   (19) Turn the Rotary Knob to highlight the **10 OHM** menu selection.
   (20) Press the Rotary Knob to select **10 OHM**.
   (21) Press the **NORMAL SCREEN** Control Key.

e. Verify sinusoidal respiration waveform and respiration rate is displayed on the monitor display screen.

f. Set Patient Simulator to 0.1 Ohm impedance.

g. Setup Respiration as follows:
   (1) Turn the Rotary Knob to highlight the **RESP** icon.
   (2) Press the Rotary Knob to select the **RESP** menu.
   (3) Turn the Rotary Knob to highlight the **SIZE** menu selection.
   (4) Press the Rotary Knob to select **SIZE**.
   (5) Turn the Rotary Knob to highlight the **0.5 OHM** menu selection.
   (6) Press the Rotary Knob to select **0.5 OHM**.
   (7) Press the **NORMAL SCREEN** Control Key.
   (8) Give the waveform time to settle.

h. Setup up the printer as follows:
   (1) Press the **RECORDER FUNCTIONS** Menu-Select Key.
   (2) Press the Rotary Knob to select **TRACE 1**.

(3) Turn the Rotary Knob to highlight the **RESP(ECG)** menu selection.

(4) Press the Rotary Knob to select **RESP(ECG)**.

i. Press the **RECORD** Control Key, wait 10 seconds and press the **RECORD** Control Key a second time.

j. Verify a waveform printout approximately 1.5 blocks in height with a distinguishable sinewave containing less than 20% noise.

k. Disconnect the Patient Simulator from the monitor front panel.

2.12 **Temperature Span and Offset Verification.** Perform the following to verify the proper operation of the Temperature system:

a. Perform the following procedure to turn Temperature On.

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **PARAMETER SELECTION** menu selection.

(3) Press the Rotary Knob to select **PARAMETER SELECTION**.

(4) Turn the Rotary Knob to highlight the **TEMP** menu selection.

(5) Press the Rotary Knob to select **TEMP**.

(6) Turn the Rotary Knob to highlight the **ON** menu selection.

(7) Press the Rotary Knob to turn the Temperature On.

(8) Press the **NORMAL SCREEN** Control Key.

b. Connect a Temperature Simulator into the T1 input on the monitor front panel.

c. Verify the following readings:

1) 20° ±0.1°C

2) 25° ±0.1°C

3) 35° ±0.1°C

4) 40° ±0.1°C

d. Disconnect the Temperature Simulator from the monitor front panel.

e. Connect Temperature Simulator into the T2 input on the monitor front panel.

f. Verify the following readings:

1) 20° ±0.1°C

2) 25° ±0.1°C

3) 35° ±0.1°C

4) 40° ±0.1°C

g. Disconnect the Temperature Simulator from the monitor front panel.

2.13 **NIBP Verification.** Perform the following to verify proper operation of the NIBP system:

a. Press the **SETUP** Control Key.

b. Turn the Rotary Knob to highlight the **SERVICE (BIO-MED)** menu selection.

c. Press the Rotary Knob to select **SERVICE (BIO-MED)**.

d. Turn the Rotary Knob to highlight the **NIBP TESTS** menu selection.

e. Press the Rotary Knob to select **NIBP TESTS**.

f. Turn the Rotary Knob to highlight the **CALIBRATE** menu selection.

g. Press the Rotary Knob to select **CALIBRATE**.

h. Verify the following:
   (1) OFFSET PRESS = 6 (±2).
   (2) PRESS READING = 0 (±2).

i. Connect Pressure Tester (Deadweight or Manometer) to the NIBP Sense Port (located next to the SpO2 Connector on the monitor front panel).

j. Perform the Pressure Test as follows:
   (1) Set the Pressure Tester for 200 mmHg.
   (2) Verify the following:
      (a) OFFSET PRESS = 206 (±2).
      (b) PRESS READING = 200 (±2).
   (3) Set the Pressure Tester for 150 mmHg.
   (4) Verify the following:
      (a) OFFSET PRESS = 156 (±2).
      (b) PRESS READING = 150 (±2).
   (5) Set the Pressure Tester for 100 mmHg.
   (6) Verify the following:
      (a) OFFSET PRESS = 106 (±2).
      (b) PRESS READING = 100 (±2).
   (7) Set the Pressure Tester for 50 mmHg.
   (8) Verify the following:
      (a) OFFSET PRESS = 56 (±2).
      (b) PRESS READING = 50 (±2).
   (9) Set the Pressure Tester for 0 mmHg.
   (10) Verify the following:
      (a) OFFSET PRESS = 6 (±2).
      (b) PRESS READING = 0 (±2).
   (11) Set the Pressure Tester for 50 mmHg.

(12) Verify the following:
   (a) OFFSET PRESS = 56 (±2).
   (b) PRESS READING = 50 (±2).

(13) Set the Pressure Tester for 100 mmHg.

(14) Verify the following:
   (a) OFFSET PRESS = 106 (±2).
   (b) PRESS READING = 100 (±2).

(15) Set the Pressure Tester for 150 mmHg.

(16) Verify the following:
   (a) OFFSET PRESS = 156 (±2).
   (b) PRESS READING = 150 (±2).

(17) Set the Pressure Tester for 200 mmHg.

(18) Verify the following:
   (a) OFFSET PRESS = 206 (±2).
   (b) PRESS READING = 200 (±2).

(19) Set the Pressure Tester for 282 mmHg.

(20) Verify the following:
   (a) OFFSET PRESS = 288 (+0/-2).
   (b) PRESS READING = 282 (±2).

(21) Release the pressure and disconnect the Pressure Tester from the Sense Port.

(22) Press the **NORMAL SCREEN** Control Key.

k. Perform Over Pressure Verification as follows:

(1) Connect a manometer to the NIBP Inflate port (on the side toward the power switch) on the front of the monitor.

(2) If the patient selection is NEO (located over the ECG Icon), perform the following to select ADULT:
   (a) Press the **SETUP** Control Key.
   (b) Turn the Rotary Knob to highlight the **PATIENT** menu selection.
   (c) Press the Rotary Knob to select **PATIENT**.
   (d) Turn the Rotary Knob to highlight the **ADULT** menu selection.
   (e) Press the Rotary Knob to select **ADULT**.

(3) Press the **NIBP START/STOP** Control Key to start the pump.

(4) Slowly close the bleed screw on the manometer hand bulb for a pressure rate of 50 mmHg per second until the manometer reaches 270 mmHg (±5).

(5) Verify that the pump shuts itself off when the above limits are violated and an "Over Pressure" warning message is displayed in the lower left hand corner of the screen.

(6) Disconnect the manometer from the NIBP Inflate port.

l. Perform Leak Time-Out Verification as follows:

(1) With nothing connected to the NIBP Ports on the monitor front panel, press the **NIBP START/STOP** Control Key.

(2) Verify that the pump shuts off after 6 seconds ±1.5 seconds and that the error message NOT INFLATING is displayed in the lower left corner of the screen.

m. Perform Calibrate Error Verification as follows:

(1) Connect the Manometer to the NIBP Sense Port that is next to SPO2 connector.

(2) Inflate the Manometer to 15 mmHg.

(3) Press the **NIBP START/STOP** Control Key.

(4) Verify that the pump does not start.

(5) After 10 seconds release pressure from the manometer and verify that the pump starts.

n. Perform Pneumatic Leak Test as follows:

(1) Connect a 20 foot leak hose to the NIBP Ports on the front of the monitor.

(2) Press the **SETUP** Control Key.

(3) Turn the Rotary Knob to highlight the **SERVICE (BIO-MED)** menu selection.

(4) Press the Rotary Knob to select **SERVICE (BIO-MED)**.

(5) Turn the Rotary Knob to highlight the **NIBP TESTS** menu selection.

(6) Press the Rotary Knob to select **NIBP TESTS**.

(7) Turn the Rotary Knob to highlight the **LEAK TEST** menu selection.

(8) Press the Rotary Knob to select **LEAK TEST**.

NOTE

The pump will start automatically and cycle approximately every 20 seconds. A difference of 10 or more between the "PEAK" and "FINAL" would be considered a failure and will register in the "failed" window.

(9) Verify a minimum of 2 Leak Test Cycles with no failures.

(10) Press the **NORMAL SCREEN** Control Key.

o. Perform Normal Blood Pressure Reading Verification as follows:

Perform the substeps below using an NIBP Analyzer if available.

(1) Perform Adult Verification as follows:

(a) Connect an Adult Cuff (IRI Part Number 9070E) to the NIBP Ports on the monitor front panel.

(b) Place the Adult Cuff on arm.

(c) If Adult mode is not selected, press the **SETUP** Control Key, turn the Rotary Knob to highlight the **PATIENT** menu selection, press the Rotary Knob and turn to highlight the **ADULT** menu selection, press the Rotary Knob and the **NORMAL SCREEN** Control Key.

(d) Press the **NIBP START/STOP** Control Key.

(e) Verify that the Cuff inflates to 180 mmHg before the pump stops and the system begins to release pressure through the bleed valves.

(f) When the blood pressure determination is complete, verify that the Systolic, Mean and Diastolic Blood Pressure numerics are present in the lower left of the screen (in the NIBP Icon).

(g) Remove the Cuff from the arm.

(h) Attach Cuff to a solid object (approximately arm size), press the **NIBP START/STOP** Control Key and verify a NIBP determination of 0 for Systolic, Mean and Diastolic.

(i) Disconnect the Cuff from the NIBP Ports on the monitor front panel.

Perform the substeps below using an NIBP Analyzer if available.

(2) Perform Neonatal Verification as follows:

(a) Connect a Neonatal Cuff (IRI Part Number AN01A or AN02A) to your finger.

(b) Connect the Neonatal Cuff to the NIBP Ports on the monitor front panel.

(c) Press the **SETUP** Control Key.

(d) Turn the Rotary Knob to highlight the **PATIENT** menu selection.

(e) Press the Rotary Knob to select **PATIENT**.

(f) Turn the Rotary Knob to highlight the **NEO** menu selection.

(g) Press the Rotary Knob to select **NEO**.

(h) Press the **NORMAL SCREEN** Control Key.

(i) Hold hand with cuffed finger above shoulder height (to ensure blood pressure reading below 100 mmHg) and press the **NIBP START/STOP** Control Key.

(j) Verify that the Cuff inflates to 110 mmHg before the pump stops and the system begins to release pressure through the bleed valves.

(k) When the blood pressure determination is complete, verify that the Systolic, Mean and Diastolic Blood Pressure numerics are present in the lower left of the screen (in the NIBP Icon).

(l) Remove the Cuff from the finger.

(m) Attach Cuff to a solid object (approximately finger size), press the **NIBP START/STOP** Control Key and verify a NIBP determination of 0 for Systolic, Mean and Diastolic.

(n) Disconnect the Cuff from the NIBP Ports on the monitor front panel.

(o) Return the Patient Selection to Adult by pressing the **SETUP** Control Key, turning the Rotary Knob to highlight the **PATIENT** menu selection, pressing the Rotary Knob and turning it to highlight the **ADULT** menu selection and pressing the Rotary Knob.

p. If an NIBP Analyzer is available, perform the NIBP Range and Accuracy Verification as follows:

(1) Adult Range and Accuracy Verification:

Systolic	Diastolic	Mean	Tolerance
45	15	(25)	±5mmHg
80	50	(62)	±5mmHg
120	80	(90)	±10mmHg
150	100	(115)	±10mmHg
245	185	(205)	±10mmHg

(2) Neonatal Range and Accuracy Verification:

Systolic	Diastolic	Mean	Tolerance
45	15	(25)	±5mmHg
80	50	(62)	±5mmHg
120	80	(90)	±10mmHg
150	100	(115)	±10mmHg
190	140	(155)	±10mmHg

The uncertainty specifications of the NIBP Analyzer must be added to the Millennia tolerances for proper accuracy verification.

Perform the SpO2 Verification with an SpO2 Simulator if available.

2.14 SPO2 Verification. Perform the following to verify proper operation of the SpO2 system:

a. Connect SpO2 Probe to the SpO2 connector on the monitor front panel.

b. Press the **SETUP** Control Key.

c. Turn the Rotary Knob to highlight the **DISPLAY SETUP** menu selection.

d. Press the Rotary Knob to select **DISPLAY SETUP**.

e. Turn the Rotary Knob to highlight the **TRACE D** menu selection.

f. Press the Rotary Knob to select **TRACE D**.

g. Turn the Rotary Knob to highlight the **SPO2** menu selection.

h. Press the Rotary Knob to select **SPO2.**

i. Place your finger into the probe and, after the monitor waveform display levels out, verify the following:

1) SpO2 Pulse occurs with the operators heart count.

2) The SpO2 % is within reasonable limits for the operator (90 to 98).

3) The Trace F SpO2 waveform is smooth with no steps.

j. Remove the probe from your finger.

k. If a SPO2 Simulator is available, verify the accuracy of Oxygen Saturation Value with Invivo probes as follows:

Oxygen Saturation	**Tolerance**
90-100%	±2%
80-90%	±2.2%
70-80%	±2.5%
60-70%	±3%

The uncertainty specifications of the SPO2 Simulator must be added to the Millennia tolerances for proper accuracy verification.

l. Disconnect the SpO2 probe from the monitor front panel.

2.15 ETCO2 Verification. (If the ETCO2 option is installed) Perform the following to verify proper operation of the ETCO2 system: 10 min warm up

a. Setup up the ETCO2 system as follows:

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **DISPLAY SETUP** menu selection.

(3) Press the Rotary Knob to select **DISPLAY SETUP.**

(4) Turn the Rotary Knob to highlight the **TRACE C** menu selection.

(5) Press the Rotary Knob to select **TRACE C.**

(6) Turn the Rotary Knob to highlight the **ETCO2** parameter selection.

(7) Press the Rotary Knob to select **ETCO2** (Note that ETCO2 and Respiration cannot be ON at the same time).

(8) Press the **NORMAL SCREEN** Control Key.

(9) Wait 15 minutes (for ETCO2 to Warm Up) before proceeding to substep b.

b. Perform CO2 Occlusion Test as follows:

(1) Turn the Rotary Knob to highlight the **ETCO2** icon.

(2) Press the Rotary Knob to select the **ETCO2** menu.

(3) Turn the Rotary Knob to highlight the **FLOW** menu selection.

(4) Press the Rotary Knob to select **FLOW.**

(5) Turn the Rotary Knob to highlight the **LOW** menu selection.
(6) Press the Rotary Knob to select **LOW**.
(7) Turn the Rotary Knob to highlight the **YES** menu selection.
(8) Press the Rotary Knob to select **YES**.
(9) Press the **NORMAL SCREEN** Control Key.
(10) Place your finger over the ETCO2 Port on the monitor front panel and verify the following:
  (a) The message "CO2 Occlusion" appears at the top of the display screen.
  (b) The pump motor speed increases in an attempt to clear the occlusion.
(11) Remove your finger from the ETCO2 Port.

c. Perform Zero Calibration for Low Flow as follows:
(1) Press the **SETUP** Control Key.
(2) Turn the Rotary Knob to highlight the **SERVICE (BIO-MED)** menu selection.
(3) Press the Rotary Knob to select **SERVICE (BIO-MED)**.
(4) Turn the Rotary Knob to highlight the **GAS CAL** menu selection.
(5) Press the Rotary Knob to select **GAS CAL**.
(6) Turn the Rotary Knob to highlight the **ZERO CAL** menu selection.
(7) Press the Rotary Knob to select **ZERO CAL**.
(8) Verify that the message "Readjusting CO2 Zero" appears in the top area of the display.
(9) Place your finger over the ETCO2 Port on the monitor front panel and verify the following:
  (a) The message "CO2 Occlusion" does **not** appear.
  (b) There is no change in the pump motor speed.
(10) Press the **NORMAL SCREEN** Control Key.
(11) Connect the CAL GAS (IRI Part Number 9010F) to the ETCO2 Port.
(12) Simulate breathing pattern (by pressing and releasing the nozzle of the can) and verify the following:
  (a) ETCO2 = 76 (±3).
  (b) N20 reading stabilizes to 50 (±4).
  (c) A waveform appears in the ETCO2 Trace area.
(13) Disconnect the Calibration Gas from the monitor.
(14) Connect Flow Meter to the ETCO2 Port on the monitor front panel and verify an air flow of 150 ml (±5ml).
(15) Disconnect the Flow Meter.

d. Perform Zero Calibration for High Flow as follows:
(1) Turn the Rotary Knob to highlight the **ETCO2** icon.
(2) Press the Rotary Knob to select the **ETCO2** menu.

(3) Turn the Rotary Knob to highlight the **FLOW** menu selection.
(4) Press the Rotary Knob to select **FLOW**.
(5) Turn the Rotary Knob to highlight the **HIGH** menu selection.
(6) Press the Rotary Knob to select **HIGH**.
(7) Turn the Rotary Knob to highlight the **YES** menu selection.
(8) Press the Rotary Knob to select **YES**.
(9) Press the **SETUP** Control Key.
(10) Turn the Rotary Knob to highlight the **SERVICE (BIO-MED)** menu selection.
(11) Press the Rotary Knob to select **SERVICE (BIO-MED)**.
(12) Turn the Rotary Knob to highlight the **GAS CAL** menu selection.
(13) Press the Rotary Knob to select **GAS CAL**.
(14) Turn the Rotary Knob to highlight the **ZERO CAL** menu selection.
(15) Press the Rotary Knob to select **ZERO CAL**.
(16) Place your finger over the ETCO2 Zero Port on the monitor back panel and verify that there is a definite change in the speed of the pump motor.
(17) Remove your finger from the ETCO2 Port.
(18) Place your finger over the ETCO2 Waste Gas Port on the back of the monitor and verify a definite change in the speed of the pump motor.
(19) Press the **NORMAL SCREEN** Control Key.
(20) Connect the CAL GAS (IRI Part Number 9010F) to the ETCO2 Port.
(21) Simulate breathing pattern (by pressing and releasing the nozzle of the can) and verify the following:
    (a) ETCO2 = 76 (±3).
    (b) N20 reading stabilizes to 50 (±4).
    (c) A waveform appears in the ETCO2 Trace area.
(22) Disconnect the Calibration Gas.
(23) Connect Flow Meter to the ETCO2 Port on the monitor front panel and verify an air flow of 230 ml (±5 ml).

SECTION III

DISASSEMBLY PROCEDURES

3.0 DISASSEMBLY PROCEDURES.

Tools Required

#2 Phillips Head Screwdriver

9/64 Ball End Allen Driver

Small Flat Head Screwdriver

3.1 Monitor Disassembly. Perform the following procedure for access to the internal printed circuits boards:

a. Disconnect AC Line Power Cord from monitor back panel.

b. Remove the batteries.

c. Remove Recorder Paper and Recorder Assembly by loosening two captivated screws located in the inner rear of the Recorder Assembly.

d. Remove PCMCIA I/O Port Cover.

e. Loosen screws on front feet of monitor enought to rotate feet 90° inward.

f. Remove six (6) screws securing cover assembly to the rear panel (two on each side and two on the top).

CAUTION

The PCMCIA Release Buttons are fragile. Take care in the following stop to ensure that the PCMCIA Release Buttons are not damaged during the removal of the Cover Assembly.

g. Open battery door, then remove cover assembly by pulling toward the rear (first from the bottom then from the top, working the assembly outward).

h. Remove the Front Panel Assembly as follows:

1) Remove three (3) screws located on the bottom of the Front Panel Assembly.

2) Loosen four (4) captivated allen screws located behind the Front Panel Assembly (two on top and two in the middle).

3) Disconnect all cables from the Front Panel Assembly.

3.2 AB69 and AB69A Removal. Remove AB69 and AB69A as follows:

a. Perform paragraph 3.1 to remove the Cover and Front Panel Assemblies.

b. Unplug the Display Driver (**AB77**) from the Processor Motherboard.

c. Unplug the A/D Board (**AB65**) from the Processor Motherboard.

d. Unplug both battery connection wires from the front of the **AB69A** board.

e. Remove four screws from **AB69A**.

f. Unplug **AB69A** from **AB69** by carefully disconnect two board-to-board connectors between the two boards.

g. Unplug the cables attached to **AB69**.

h. Unscrew the standoffs protruding from the **AB69** and lift the board from its mounting.

SECTION IV

ADJUSTMENT PROCEDURES

4. ADJUSTMENT PROCEDURES.

4.1 ECG/Recorder Gain Adjustment. Perform the following procedure to adjust the ECG/Recorder Gain:

CAUTION

The **Millennia™ Vital Signs Monitor** contains a great number of Static Sensitive circuits. Proper handling procedures must be followed when touching any Printed Circuit Board (PCB) as static voltages usually present on clothing and personnel present great risk of damage to the circuits. **All Service Procedures MUST be done by Properly Grounded Personnel at a Static Free Work Station.**

4.1.1 ECG Trace A Adjustment. Perform the following procedure to adjust the Gain of ECG Trace A.

a. Remove top cover and loosen front panel assembly (Reference Section III: Disassembly Procedures) leaving all Cables connected. Reinstall the Recorder Unit.

b. Turn power on.

c. Turn the Rotary Knob to highlight the **ECG** icon.

d. Press the Rotary Knob to select the **ECG** menu.

e. Turn the Rotary Knob to highlight **TRACE A LEAD** menu selection.

f. Press the Rotary Knob to select **TRACE A LEAD.**

g. Turn the Rotary Knob to highlight **LEAD II** menu selection.

h. Press the Rotary Knob to select **LEAD II.**

i. Turn the Rotary Knob to highlight **TRACE B LEAD** menu selection.

j. Press the Rotary Knob to select **TRACE B LEAD.**

k. Turn the Rotary Knob to highlight **OFF** menu selection.

l. Press the Rotary Knob to select **OFF.**

m. Turn the Rotary Knob to highlight **SCALE** menu selection.

n. Press the Rotary Knob to select **SCALE.**

o. Turn the Rotary Knob to highlight **20mm/mv** menu selection.

p. Press the Rotary Knob to select **20mm/mv.**

q. Turn the Rotary Knob to highlight **FILTER MODE** menu selection.

r. Press the Rotary Knob to select **FILTER MODE**.

s. Turn the Rotary Knob to highlight **DIAG** menu selection.

t. Press the Rotary Knob to select **DIAG**.

u. Press the **RECORDER FUNCTIONS** key.

v. Turn the Rotary Knob to highlight **TRACE 1** menu selection.

w. Press the Rotary Knob to select **TRACE 1**.

x. Turn the Rotary Knob to highlight **ECG 1** menu selection.

y. Press the Rotary Knob to select **ECG 1**.

z. Turn the Rotary Knob to highlight the **TRACE 2** menu selection.

aa. Press the Rotary Knob to select **TRACE 2**.

ab. Turn the Rotary Knob to highlight the **OFF** menu selection.

ac. Press the Rotary Knob to select **OFF**.

ad. Turn the Rotary Knob to highlight **SWEEP SPEED** menu selection.

ae. Press the Rotary Knob to select **SWEEP SPEED**.

af. Turn the Rotary Knob to highlight **50 mm/s** menu selection.

ag. Press the Rotary Knob to select **50mm/s**.

ah. Set ECG simulator to output a square wave of 1 mv at 2 Hz.

ai. Press the **RECORD** Control Key.

aj. Wait 5 seconds and press the **RECORD** Control Key a second time.

ak. Adjust AB66 R93 (clockwise to decrease the gain and counter clockwise to increase the gain) for a reading of 20mm (4 blocks) ±5% (1 mm) (Reference Figure 4-1). Repeat steps ae, af and ag until the gain is adjusted to within limits. Press the **NORMAL SCREEN** Control Key when the adjustment procedure is correct.

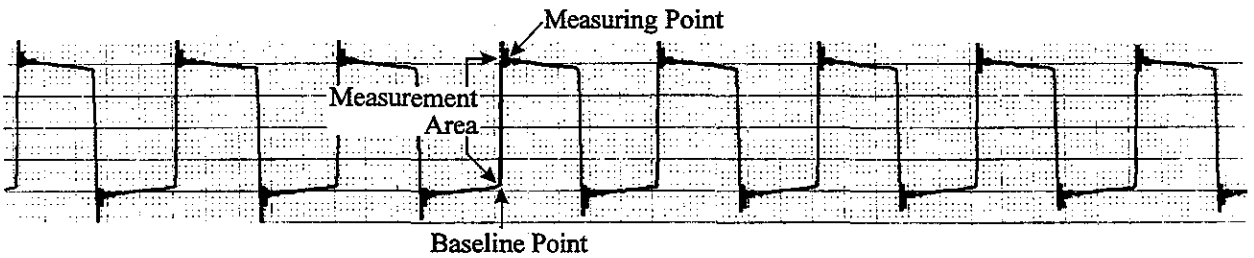

Figure 4-1. Measurement Area for Determining Proper ECG Gain Adjustment

4.1.2 ECG Trace B Adjustment. Perform the following procedure to adjust the Gain of ECG Trace B.

a. Remove top cover and loosen front panel assembly (Reference Section III: Disassembly Procedures) leaving all cables connected.

b. Turn power on.

c. Turn the Rotary Knob to highlight the **ECG** icon.

d. Press the Rotary Knob to select the **ECG** menu.

e. Turn the Rotary Knob to highlight **TRACE A LEAD** menu selection.

f. Press the Rotary Knob to select **TRACE A LEAD**.

g. Turn the Rotary Knob to highlight **OFF** menu selection.

h. Press the Rotary Knob to select **OFF**.

i. Turn the Rotary Knob to highlight **TRACE B LEAD** menu selection.

j. Press the Rotary Knob to select **TRACE B LEAD**.

k. Turn the Rotary Knob to highlight **LEAD II** menu selection.

l. Press the Rotary Knob to select **LEAD II**.

m. Turn the Rotary Knob to highlight **SCALE** menu selection.

n. Press the Rotary Knob to select **SCALE**.

o. Turn the Rotary Knob to highlight **20mm/mv** menu selection.

p. Press the Rotary Knob to select **20mm/mv**.

q. Turn the Rotary Knob to highlight **FILTER MODE** menu selection.

r. Press the Rotary Knob to select **FILTER MODE**.

s. Turn the Rotary Knob to highlight **DIAG** menu selection.

t. Press the Rotary Knob to select **DIAG**.

u. Press the **RECORDER FUNCTIONS** key.

v. Turn the Rotary Knob to highlight **TRACE 1** menu selection.

w. Press the Rotary Knob to select **TRACE 1**.

x. Turn the Rotary Knob to highlight **ECG 2** menu selection.

y. Press the Rotary Knob to select **ECG 2**.

z. Turn the Rotary Knob to highlight **SWEEP SPEED** menu selection.

aa. Press the Rotary Knob to select **SWEEP SPEED**.

ab. Turn the Rotary Knob to highlight **50 mm/s** menu selection.

ac. Press the Rotary Knob to select **50mm/s**.

ad. Set ECG simulator to output a square wave of 1 mv at 2 Hz.

ae. Press the **RECORD** Control Key.

af. Wait 5 seconds and press the **RECORD** Control Key a second time.

ag. Adjust AB66 R93 (clockwise to decrease the gain and counter clockwise to increase the gain) for a reading of 20mm (4 blocks) ±5% (1 mm) (Reference Figure 4-1). Repeat steps ae, af and ag until the gain is adjusted to within limits. Press the **NORMAL SCREEN** Control Key when the adjustment procedure is correct.

ah. Perform ECG Verification (Section 2).

4.2 NIBP Adjustments. Perform the following procedure to adjust the NIBP System:

4.2.1 NIBP Offset and Gain Adjustments. Perform the following procedure to adjust the NIBP DC Offset and Gain:

a. Remove top cover and loosen front panel assembly (Reference Section III: Disassembly Procedures) leaving all Cables connected.

b. Turn power on.

c. Perform Offset Adjust as follows:

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **SERVICE (BIO-MED)** menu selection.

(3) Press the Rotary Knob to select **SERVICE (BIO-MED)**.

(4) Turn the Rotary Knob to highlight the **NIBP** menu selection.

(5) Press the Rotary Knob to select **NIBP**.

(6) Turn the Rotary Knob to highlight the **CALIBRATE** menu selection.

(7) Press the Rotary Knob to select **CALIBRATE**.

(8) Adjust AB66 R177 for OFFSET PRESS reading of 5.

(9) Press the Rotary Knob to exit the Calibration Screen.

(10) Press the **NIBP START/STOP** Control Key to start the NIBP pump, then press the **NIBP START/STOP** Control Key to stop the pump.

(11) Turn the Rotary Knob to highlight the **Calibrate** menu selection.

(12) Press the Rotary Knob to select **Calibrate**.

(13) Connect Manometer to NIBP Sense Port (the port on the left next to the SpO2 Connector).

(14) Apply 200 mmHg and note the difference from 200 displayed in the PRESS READING window.

(15) Release the pressure from the manometer by opening the valve on the hand bulb.

(16) Adjust AB66 R176 for the difference noted (i.e.: 202 mmHg would be a difference of +2 and 198 mmHg would be a difference of -2) in substep 14 above (the adjustment value is provided in the PRESS READING window).

(17) Adjust AB66 R177 for OFFSET PRESS reading of 5.

(18) Press the Rotary Knob to exit the Calibration Screen.

(19) Press the **NIBP START/STOP** Control Key to start the NIBP pump, then press the **NIBP START/STOP** Control Key to stop the pump.

(20) Turn the Rotary Knob to highlight the **Calibrate** menu selection.

(21) Press the Rotary Knob to select **Calibrate**.

(22) Apply 200 mmHg and note the difference from 200 displayed in the PRESS READING window.

(23) Release the pressure from the manometer by opening the valve on the hand bulb.

(24) Adjust AB66 R176 for the difference noted (i.e.: 202 mmHg would be a difference of +2 and 198 mmHg would be a difference of -2) in substep 14 above (the adjustment value is provided in the PRESS READING window).

(25) Repeat substeps 17 through 25 as necessary.

4.2.2 NIBP Overpressure Switch Adjustment. Perform the following procedure to adjust the NIBP Overpressure Switch:

a. Connect a manometer to the NIBP Inflate port on the front of the monitor.

b. If the patient selection is NEO (located over the ECG Icon), perform the following to select ADULT:

(1) Turn the Rotary Knob to highlight the **PATIENT** menu selection.

(2) Press the Rotary Knob to select **PATIENT**.

(3) Turn the Rotary Knob to highlight the **ADULT** menu selection.

(4) Press the Rotary Knob to select **ADULT**.

c. Press the **NIBP START/STOP** Control Key to start the pump.

d. Slowly close the bleed screw on the manometer hand bulb at a rate of 50 mmHg per second until the manometer reaches 270 mmHg (±5).

e. Verify that the pump shuts itself off when the above limits are violated and an "Over Pressure" warning message is displayed in the lower left hand corner of the screen.

f. Using a 0.05 mm ball end hex driver, adjust the switch (located on the AP31 Pneumatics Assembly) until substep e passes.

g. Disconnect the manometer from the NIBP Inflate port.

h. Perform NIBP Verification (Section II).

4.3 Invasive Pressure Adjustments. Perform the following procedure to adjust the Invasive Pressure System.

a. Remove top cover and loosen front panel assembly (Reference Section III: Disassembly Procedures) leaving all cables connected.

b. Turn power on.

c. Setup the Invasive Pressure System as follows:

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **PARAMETER SELECTION** menu selection.

(3) Press the Rotary Knob to select **PARAMETER SELECTION**.

(4) Turn the Rotary Knob to highlight the **P1** menu selection.
(5) Press the Rotary Knob to select **P1**.
(6) Turn the Rotary Knob to highlight the **ON** menu selection.
(7) Press the Rotary Knob to select **ON**.
(8) Turn the Rotary Knob to highlight the **P2** menu selection.
(9) Press the Rotary Knob to select **P2**.
(10) Turn the Rotary Knob to highlight the **ON** menu selection.
(11) Press the Rotary Knob to select **ON**.

d. Set the Pressure Simulator to output 000 mmHg with the Zero switch on.

e. Setup Invasive Pressure 1 as follows:
(1) Turn the Rotary Knob to highlight the **P1** Icon.
(2) Press the Rotary Knob to bring up the **P1** Menu.
(3) Press the Rotary Knob to select the **ZERO SET** menu selection.
(4) Verify successful zeroing of Pressure Channel 1.
(5) Press the Rotary Knob to select OK.

f. Verify the P1 numerics indicate Zero ±1 count.

g. Press the **NORMAL SCREEN** Control Key.

h. Adjust the Pressure Simulator as follows:
(1) Set the Pressure Simulator Zero switch to "+."
(2) Set the Pressure Simulator to output 200.

pots on front side of frontend board

i. After reading settles, adjust AB66 R144 for a display reading of 200 (±1). (Repeat substeps d through i as necessary.)

j. Set the Pressure Simulator to output 000 mmHg with the Zero switch on.

k. Setup Invasive Pressure 2 as follows:
(1) Turn the Rotary Knob to highlight the **P2** Icon.
(2) Press the Rotary Knob to bring up the **P2** Menu.
(3) Press the Rotary Knob to select the **ZERO SET** menu selection.
(4) Verify successful zeroing of Pressure Channel 2.
(5) Press the Rotary Knob to select OK.

l. Verify the P2 numerics indicate Zero ±1 count.

m. Press the **NORMAL SCREEN** Control Key.

n. Adjust the Pressure Simulator as follows:
(1) Set the Pressure Simulator Zero switch to "+."
(2) Set the Pressure Simulator to output 200.

o. After reading settles, adjust AB66 R145 for a display reading of 200 (±1). (Repeat substeps j through o as necessary.)

p. Perform Invasive Pressure Verification (Section II).

4.4 ETCO2 Adjustment Procedure. Perform the following procedure to adjust the ETCO2 System.

a. Remove top cover and front panel assembly (Reference Section III: Disassembly Procedures).

b. Remove AS191 (ETCO2 Module) as follows:

(1) Remove the left and right retainer brackets from the support brackets.

(2) Disconnect the Nafion Tube Dryer from the check valve assembly.

(3) Slide AS191 forward disconnecting from Mother Board.

(4) Disconnect the Zero Port tubing from relay valve V1.

(5) Disconnect the Exhaust Port tubing from relay valve V3.

(6) Remove AS191 and place on a non-conductive surface beside the monitor.

c. Disconnect pump motor cable from J2.

d. Reconnect cables to AB66.

e. Turn the monitor on.

f. Turn on the ETCO2 in the Trace C location as follows:

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **DISPLAY SETUP** menu selection.

(3) Press the Rotary Knob to select **DISPLAY SETUP**.

(4) Turn the Rotary Knob to highlight the **TRACE C** menu selection.

(5) Press the Rotary Knob to select **TRACE C**.

(6) Turn the Rotary Knob to highlight the **ETCO2** parameter selection.

(7) Press the Rotary Knob to select **ETCO2**.

(8) Press the **NORMAL SCREEN** Control Key.

g. Wait 15 minutes for ETCO2 to warm up.

h. Obtain the correct barometric pressure reading and perform the following calculation: Barometric Pressure (Hg.) x 25.4 mm/in. x 0.005 v/mmHg (the value should be approximately 3.800 Vdc).

i. Perform the following adjustments using AS191 R34 leg near the board edge as reference ground:

(1) Connect DMM to J1 Pin 7.

(2) Adjust AS191 R25 for the value calculated in substep h above.

(3) Disconnect the DMM from J1 Pin 7.

(4) Connect DMM to J1 Pin 6.

(5) Adjust AS191 R26 for 1.000 Vdc ±10 mV.

(6) Disconnect DMM from J1 Pin 6.

j. Carefully remove the tubing from U6 Transducer port near C12.

k. Use a manometer and proper size tubing to apply 100 mmHg to the U6 Transducer port.

l. Perform the following adjustments using AS191 R34 leg near the board edge as reference ground:

(1) Connect DMM to J1 Pin 6.

(2) Adjust AS191 R28 for 2.000 Vdc ±10mV.

(3) Recheck DMM reading with and without pressure to U6 adjusting AS191 R26 and AS191 R28 as necessary.

m. Turn monitor power off.

n. Reinstall the ETCO2 module as follows:

(1) Reconnect tubing to U6.

(2) Reconnect pump motor cable at J2.

(3) Disconnect cables from AB66 and remove front panel assembly.

(4) Reconnect Exhaust Port tubing to V3.

(5) Reconnect Zero Port tubing to V1.

(6) Install the ETCO2 module taking care that none of the tubing is pinched.

(7) Reconnect the Nafion Tube dryer to the check valve assembly.

(8) Install Retainer brackets.

(9) Reconnect cables to AB66.

o. Turn monitor power on.

p. Turn on the ETCO2 in the Trace C location as follows:

(1) Press the **SETUP** Control Key.

(2) Turn the Rotary Knob to highlight the **DISPLAY SETUP** menu selection.

(3) Press the Rotary Knob to select **DISPLAY SETUP**.

(4) Turn the Rotary Knob to highlight the **TRACE C** menu selection.

(5) Press the Rotary Knob to select **TRACE C**.

(6) Turn the Rotary Knob to highlight the **ETCO2** parameter selection.

(7) Press the Rotary Knob to select **ETCO2**.

(8) Press the **NORMAL SCREEN** Control Key.

q. Wait 15 minutes for ETCO2 to warm up.

r. Set the ETCO2 to Low Flow as follows:

(1) Turn the Rotary Knob to highlight the **ETCO2** icon.

(2) Press the Rotary Knob to select the **ETCO2** menu.

(3) Turn the Rotary Knob to highlight the **FLOW** menu selection.

(4) Press the Rotary Knob to select **FLOW**.

(5) Turn the Rotary Knob to highlight the **LOW** menu selection.

(6) Press the Rotary Knob to select **LOW**.